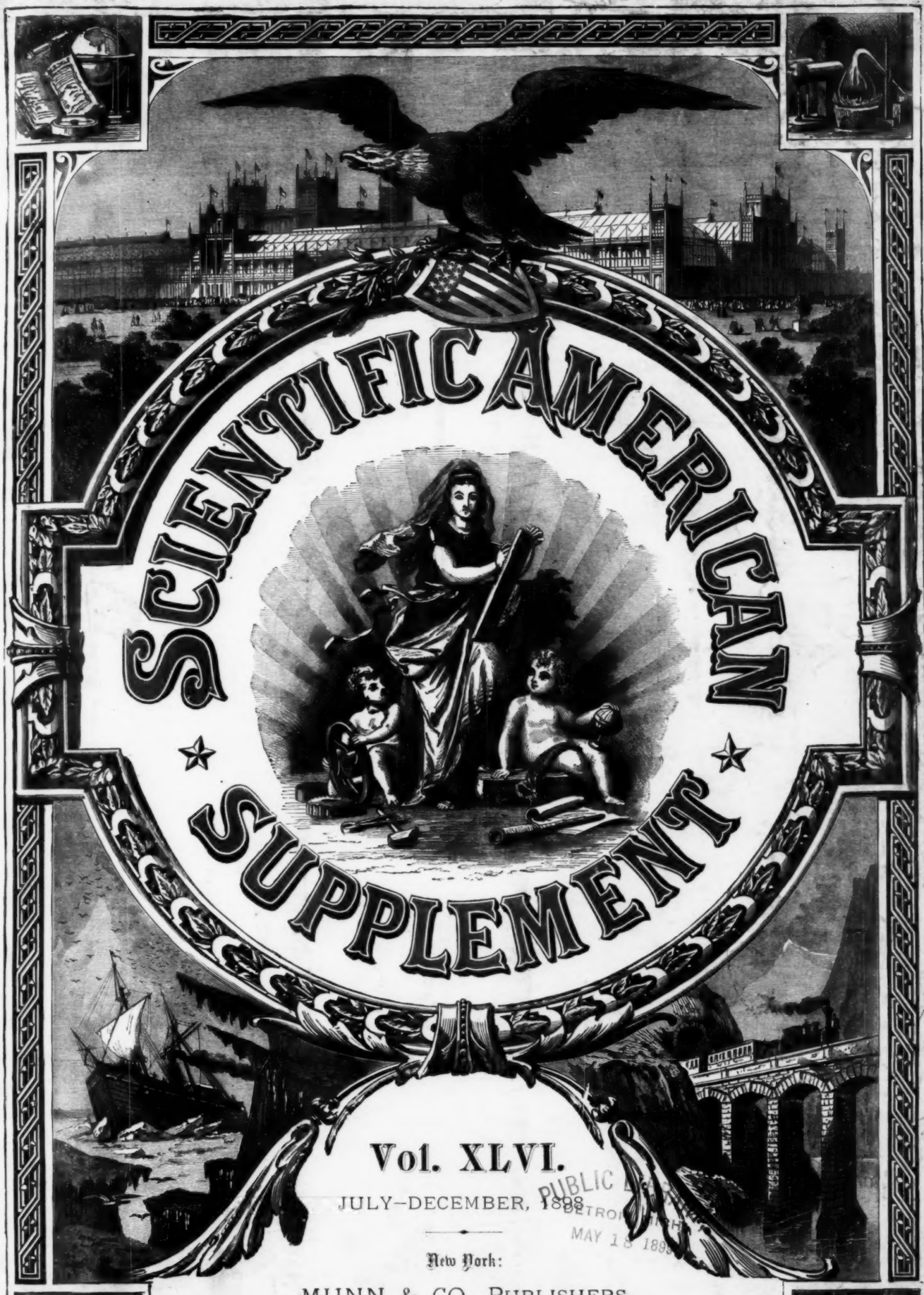

Vol. XLVI.

JULY–DECEMBER, 1898

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COMPETITION OF AUTOMOBILE HACKNEY CARRIAGES.

In the first article of its by-laws, the Automobile Club of France specifies its object in qualifying itself as a society for the encouragement of the automobile industry, and in its programme figure races, competitions, exhibitions, lectures and meetings.

It must be recognized that this programme is faithfully followed. After the Paris-Marseilles race of 1896, the lectures and the competition of heavy weights in 1897, the club organized the competition of hacks, and the Paris-Amsterdam race of 1898, in awaiting a meeting of which the date could not be better fixed than for 1900. We wish at present to call the attention of our readers especially to the competition of hackney carriages, which began on the first of June and lasted until the twelfth. All the vehicles that took part in the contest figured at the exposition, which opened on the fifteenth of June, in the garden of the Tuileries, and closed on the thirtieth.

Twelve competitors, presenting together twenty-six vehicles, responded to the call of the Automobile Club, despite the severity of the programme, which made obligatory a daily run of 36 miles, at a minimum, within a period of 16 hours.

The vehicles admitted to the competition figured in the following six categories:

I.—a. Closed carriages for two persons. b. Open carriages, with hood, for two persons. c. Mixed carriages for two persons, capable of being instantaneously closed or opened.

II.—a. Carriages for four persons, with space for baggage (65 pounds to each person). b. Open carriages, with hood, for four persons.

III.—Closed carriages for six persons, with space for baggage (65 pounds to each person).

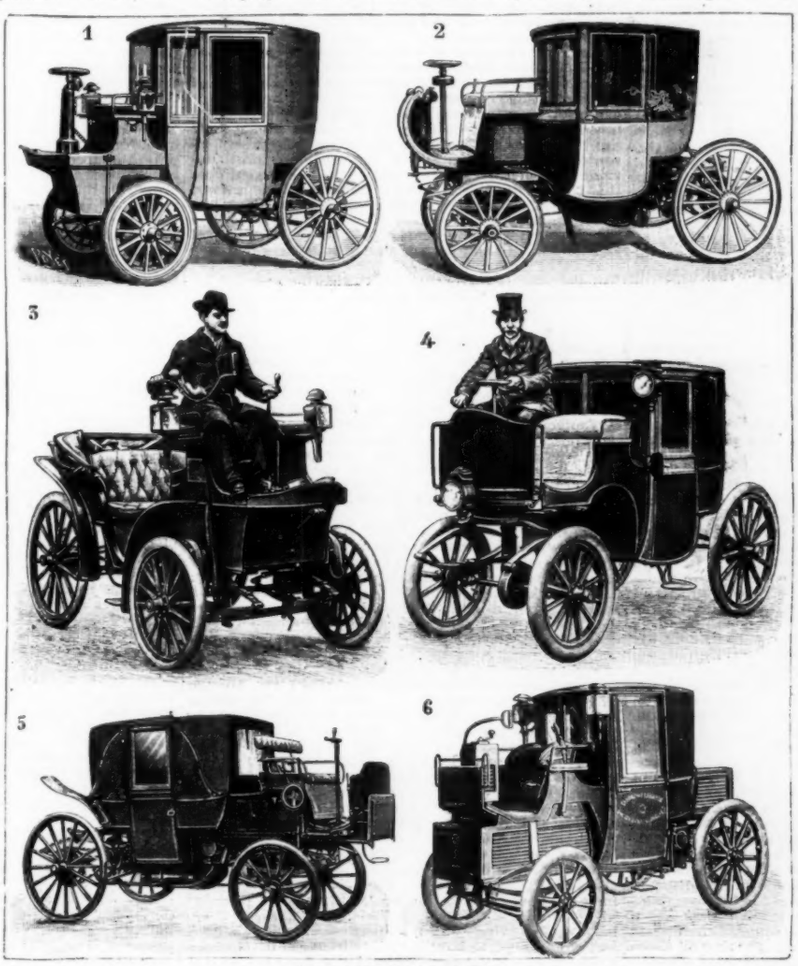
The vehicle had to be so constructed that all the passengers should be comfortably installed therein, and had to be provided with an odometer or a kilometric counter with two brakes, one progressive and the other instantaneous. Out of the 26 vehicles booked, 16 were electric and 10 gasoline.

The first of June was devoted to an examination of the conditions of establishment and of the system and running of the vehicles. From June 2 to June 10, the carriages had to make nine specific itineraries, the same for all. On the 11th, the experiments of the first of June were repeated, in order to ascertain the disturbances that had been introduced into the running of the vehicles by a service of nine consecutive days. On the 12th, the day of the grand prize, the carriages went to Versailles and returned through the Bois de Boulogne, in order to figure in the classic return of this very Parisian solemnity.

In the nine itineraries, commissioners accompanied each vehicle and carefully noted upon a service sheet all the incidents of the daily trip, the real speed upon a level and upon certain known gradients, etc.

The jury consisted of twelve members, six selected from members of the club and six selected by the competitors. The report of this jury has, up to the present, not been made known.

By giving a glance at the nine accompanying figures, from La Nature, our readers will be able to obtain an idea of the forms of the automobile carriages that will be running in Paris before the end of the year.



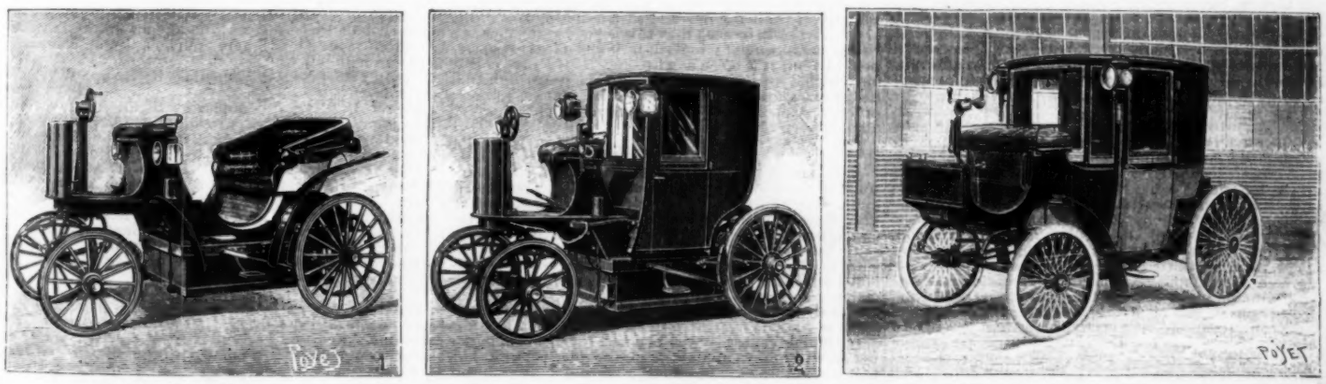
AUTOMOBILE CARRIAGES.

1. Krieger Electric Coupe. 2. Panhard Gasoline Coupe. 3. Krieger Electric Victoria. 4. Dore Electric Coupe. 5. Panhard Gasoline Landau. 6. Coupe of the Automobile Conveyance Company.

THE WORK DONE IN HAMMERING.

Mr. Ch. Fremont has recently contributed to the Proceedings of the French Society of Civil Engineers the results of some very interesting observations on the work done by hammer men in riveting or at the forge. By means of kinematographs he was able to trace the full line of travel of the hammer in different cases, and to calculate the work done with considerable accuracy. The rivet hammers used weighed from 3·3 pounds to 3·7 pounds each, or 4·4 pounds with handle included. Completing the head was done with hammers weighing 9·9 pounds to 11 pounds each, these being used either swung or raised. The photographs showed that on the rise the hammer moves slowly, but rapidly increases in speed on its descent. Using heavy hammers without swinging them, a good striker makes 12 blows in 15 seconds, and does in this time 2,386 foot-pounds of work, or 159 foot-pounds per second. This rate cannot, however, be maintained, and if the periods of rest are few and short, as in horseshoe making, the rate of work falls to 108 or 115 foot-pounds per second.

On the other hand, an exceptionally good man can for a short period work at the rate of 202 foot-pounds per second. When in place of the hammer having a movement of a quadrant only, it is swung the full circle, fewer blows are struck per minute, but the work done by each blow is greater. Thus with a 15·4 pound hammer about nine blows would be struck in 15 seconds, each of which would accomplish 231 foot-pounds of work; but the rate of working falls to 137·4 foot-pounds per second. Striking a side instead of a down blow, an ordinary man not specially accustomed to such work strikes 12 blows in 15 seconds with a heavy sledge, each of which is equivalent to from 145 to 159 foot-pounds, and the rate of work is 123 foot-pounds per second. With riveters accustomed to strike in this fashion about 10 per cent. better results are obtained. Usually, however, they



FRENCH ELECTROMOBILE CARRIAGE COMPANY—1. VICTORIA. 2. COUPE. PEUGEOT GASOLINE CARRIAGE.

TYPES OF AUTOMOBILE CARRIAGES NOW IN USE IN PARIS.

use a lighter sledge, weighing about 10 pounds, and with this can strike 13 to 14 blows in 15 seconds, doing 108 foot-pounds per second. Swinging the sledge, the number of blows falls to 10 in 15 seconds, but the rate of work is unaltered, owing to the blows being heavier.

When striking on a snap, the rate of work is 20 per cent. less. The hand hammers used by riveters weigh 4 pounds to 4½ pounds each, and the work done per blow is 58 to 65 foot-pounds per second, 4 blows being struck in 5 seconds. Smiths using a 5½ pound hammer strike one blow per second, and do work at the rate of 72 foot-pounds per second. In a shoeing forge the results are about 20 per cent. better. In general it was found that with hammers weighing from 2 pounds to 15 pounds the work done was very uniformly equivalent to that due to a fall from a height of 13½ feet.

[Continued from SUPPLEMENT, No. 1173, page 18774.]

PATENTS.*

By JAMES W. SEE, Hamilton, Ohio, Member of the Society.

MODIFICATIONS.

IT frequently happens that an inventor, in applying for his patent, can show the preferred structure and lay the foundation for broad claims, while at the same time he can see various modifications capable of the same result. In such case the inventor is often desirous of illustrating such modifications in his patent, and patent solicitors often yield to the desire. It is generally unwise to illustrate and describe modifications. The claim should be of scope to cover the invention and mere modifications of it, regardless of whether those modifications are or are not set forth, and regardless of whether the inventor has conceived of them, so long as they are mere modifications. If he does show modifications, he might in court run up against a rule of law that where there is an enumeration the matter is limited to the enumeration. An infringement might employ a mere modification not comprehended by the enumeration. Again, it is a maxim of law that a mere modification is comprehended by a claim. When the patent is taken into court, it might happen that some enumerated modification might be found to be old in the prior art, and in such case the claim would fail. If no modification were shown in the patent, then the patentee would be at liberty to deny that the given old device was a modification covered by his claim, thus possibly having his patent maintained for the structure shown in it. If the old modification was set forth, then the patentee could not deny that it was a mere modification of his invention, and that his so-called invention was a mere modification of the old device. Therefore, set forth only the preferred form of the invention, and depend on the scope of the claims.

DIVISIONAL PATENTS.

It may not be possible to cover the several segregable features of a given machine in a single patent. The law contemplates a patent for an invention and not for a number of inventions, and the classification of inventions in the Patent Office, and the organization of the examining bureaus, largely control in determining the matter of divisional applications. A bicycle may be invented which is new and patentable viewed as a whole structure. In such case the claim would recite all of the elements essentially involved in the new organization. But in this bicycle the pneumatic tire may of itself be new and patentable, and the wheel may be of a novel construction, and the lock-nut may be new, and the driving-chain may be new, and there may be a new means for securing the joints of the tubing. These matters cannot be covered in one patent. The improved tire would be viewed as being entirely independent of the peculiarity of the bicycle, and would be susceptible of employment on other kinds of bicycles or vehicles; the wheel construction might be employed in other kinds of bicycles or in wheelbarrows; the chain might be employed in varying situations calling for the use of driving-chains. In the Patent Office the wheel of a bicycle is not treated as a bicycle wheel but as a wheel, for any purpose for which it may be suited. A bicycle chain is not called a bicycle chain, and applications for patents on chains are not examined by the examiner who examines bicycle applications. Lock-nuts constitute a sub-class by themselves. The fact that the arts have recognized these separate sub-classes of devices, and that the Patent Office classification of inventions deals with them as separate and independent elements in the arts, and that the examining divisions of the Patent Office deal exclusively with given matters, all these facts go to the merit of the question of division of application. The single patent can cover only such matters as are necessarily interrelated to each other. The patent on the bicycle can cover the improved lock-nut in its combination relationship to other features of the bicycle, but it cannot contain a claim covering the lock-nut by itself. The lines of division in the Patent Office are reasonable and necessary lines, and questions of doubt will, on review, generally be resolved in favor of the applicant. If the applicant can afford it, he would be wise to resolve these doubts in favor of separate applications.

SOLICITORS.

Solicitors' fees cover the extended conferences or voluminous correspondence with the inventor; the preparation of the application; the prosecution of it in the Patent Office; the guarding of the inventor's interest in securing all that he is entitled to; and the delivery of the patent. The work is not to be measured by the complexity or simplicity of the invention. An improvement in carpet tacks might involve very much more legal work than an improvement in locomotives. The money value of an invention is often determinable by the merit of the patent granted upon it, and care should be used not to destroy the value of the property at the very start by getting the patent as cheaply as possible. The inventor sees but little of the actual work done by the patent solicitor, the real work being done generally after the application is filed in the Patent Office. It is then that the battle takes place, and it is then that the inventor's property is to be made good or bad. It does not follow that the highest priced service is the best, but it is not likely that the best or even good service will be found at low price.

The selection of a solicitor by an inventor is often to be controlled by the character of the invention. Thus a given invention may call for peculiar mechanical skill on the part of the solicitor. Almost all solicitors will be found competent to grasp most mechanical inventions, but a case occasionally arises where extraordinary mechanical skill is required in drawing distinctions between the new invention and its predecessor, the procuration of the patent thus depending very largely upon mechanical skill on the part of the solicitor. In such a case select a solicitor skilled in mechanics, or in the special branch of mechanics involved in the invention. Another invention may be simple in its device, but the question of obtaining the patent may depend entirely upon fine-spun legal considerations. In such case the solicitor brilliant in the law and dull in mechanics might be the better man. Again, the brilliant mechanic and lawyer might be less preferable than a less talented solicitor in connection with a chemical case. Again, it is always desirable in important cases to have solicitors who have had experience in the particular line in question. Thus, for instance, if one has an important and complicated invention in textile machinery, he would be wise to have a New England solicitor, or one who has had New England experience, for that section is the home of the textile arts of this country, and the solicitors of that section have had much more experience than those of other sections. In metallurgy, and in machinery of the soil and harvest, the most competent solicitors would most likely be found in other sections. For general purposes, however, it may be stated that the competent solicitor can quickly get within his grasp the salient points of almost any invention. If he has had proper training and experience, the inventor will often be astonished at his capacity for tearing an invention into pieces, sifting out the chaff and getting right down to the kernel of the invention. Many inventors do not know what their invention is until advised by their solicitors. It is a mistake to suppose that the mechanic is a better solicitor than the lawyer. The lawyer's education is one of analysis, and any mechanic is a better mechanic after studying law. The patent solicitor must have a grasp of the law and of mechanics. He may be a lawyer who has studied mechanics, or he may be a mechanic who has studied law. But it is the law training which fits the solicitor for quick grasp and thorough analysis.

CONTINGENT FEES.

There are all kinds of patent solicitors, as there are all kinds of mechanical engineers and machinists. Perhaps thorough solicitors and engineers and machinists are the exception. The best engineers and machinists can and do generally command the best pay, and so do the best patent solicitors. Those whose competency or reputation will not secure them business at good pay must be content to take poor pay. It may, I think, generally be assumed that the service in any branch which commands the best pay is the best service, but it does not at all follow that in all cases the best men are getting the best pay. Solicitors who do business on the principle of "No patent no pay" sometimes do as good work as any one, but the principle is generally availed of by those who cannot otherwise command a satisfactory amount of business. A solicitor of well established reputation is always in a position to offer his best services, but his best services may not succeed. The more difficult the road to success, the greater the need becomes for good service, and the more service is required, hence the inconsistency of contingent fees when coupled with low fees. But the worst aspect of contingent fees is that they are due when the service results in a patent with the ribbon on it. When it is considered that a patent is often the deed for a very valuable piece of property, it is obvious that the mere cost of the deed should not be too closely considered. In giving consideration to patent business done on contingent fees, sight should not be lost of the fact that contingent fees are often coupled with the lowest scale of charges. If the charges are low and then made contingent, special caution is suggested.

But there are cases in which a poor inventor must avail himself of the contingent fee system, but it does not follow that the poor inventor should therefore have poor service. He might, perhaps, go to the best solicitor and say to him, "I am poor and want the best legal services, but I cannot meet your charges, and would need to borrow money to meet any charges. I cannot afford the risk of loss, but if I get my patent I will be a rich man. Therefore, join with me in the risk, give me your best service, and if you succeed charge me extra to compensate you for your share of the risk." Some good solicitors can be got to render their best services under such an arrangement, the contingent fee being never less than double the ordinary fee. It will be seen that this is not by any means a cheap arrangement; indeed, it is the most expensive possible, but it is often a wise one. It is a safe course only with a solicitor whose reputation is so high that he cannot afford to lower the character of his work in order to expedite the getting of the patent on which alone his fee depends.

INFRINGEMENTS.

A manufacturer, aware of possible infringement upon a given patent, may compare his proposed machine with the terms of the claim of the patent, and may find that his machine escapes the terms of the claim, but he will be quite in the dark as to his status until he becomes advised as to whether or not the state of the prior art was such as to prevent the patentee invoking such a liberal interpretation for his claims as would dominate the proposed structure. Bitter fights occur over questions of infringement, the same as they do over all other asserted titles to property. The inventor creates the new invention and gets his patent, and then may arise a conflict between him and the public; the public seeking to get around the terms of his claim, and he seeking to have its terms expanded to dominate the fancied infringements. If all inventors were pioneers in their lines, then justice could easily be measured out. But in the march of industrial development each inventor adds his mite, and his exclusive rights should be protected, but are often difficult to measure. An inventor may have fancied himself a pioneer and may have gone into the Patent Office with his application, making broad claims. Upon being rejected, in view of the state of the art, he cuts down the scope of his claims, and upon further rejection he cuts down the claim still more, and advances arguments showing delicate distinctions. He then gets his patent and often seeks to hold it over the heads of the public, as having considerable breadth of scope. It is here that the delicate duties of the court are called for in determining the proper limitations to the claim, and hotly contested facts and expert testimony become in order. The courts have referred to cases of this kind by likening certain patent claims to the nose of wax which is twisted one way to get the claim from the Patent Office, and then twisted the other way to make it reach and dominate an alleged infringement. Experts will always disagree over shadowy lines. The deed to real estate calls for land to the center of the river, but the river has long since dried up and geological experts may well differ over its former location.

GOVERNMENT DEFENSE OF PATENTS.

Many patentees complain that the Government grants them patents, and then forces on them the burden of maintaining them; that Government courts often declare the patents weak or void; and they think the Government should sustain its grants.

This view ignores the fact that the Government, in making the grant, can act only on the facts before it. The inventor makes oath that he is the original and sole inventor. It may turn out that the oath is false, and that the invention was got complete from the actual inventor and patented with his consent. The Government should not be called on to uphold any such patent. Again, the Government experts search prior patents and the literature of the art, and use their own personal knowledge, and, finding nothing of an anticipating character, the patent is granted. The Government has made $15 worth of searches, and the inventor appears to be entitled to his patent, and the patent is accordingly granted. But the Government has no possible means of knowing of unpatented prior public uses. You may invent a peculiar steam engine, and build and sell them for ten years. Some man, a thousand miles from you, invents the same thing, and very properly gets a patent on it, the Government having no knowledge whatever of your past efforts. That patent must fall and the Government should not be asked to uphold it.

Again, an inventor applies for his patent and the Commissioner rejects him on some old patent which appears to be of anticipating character. Thereupon the inventor files a sophistical argument as to the construction and action of the alleged anticipation, and the examiner, half convinced and resolving doubts in favor of the applicant, allows the application and the patent is issued. Later, when the patent is taken into court, daylight is let into the sophistry of the argument and it is shown that the old device is the same as the new device. The new patent must fall.

COPIES OF PATENTS.

The Government has printed copies of almost all its issued patents, and manufacturers and others having to do with patents should more fully avail themselves of this fact. They would do well, if much concerned with patents, to have volumes containing copies of those of interest. The Patent Office divides inventions into something over 200 classes, and these classes are again divided into sub-classes on more or less rational lines. There are over 6 000 of these sub-classes. The Patent Office will furnish free on application a classification list. Copies of single patents may be purchased for five cents each; if a complete sub class is taken, for three cents each; if a complete class is taken, two cents each. Any person can procure these copies from the Patent Office at the above figures. The patent attorney would necessarily charge for services in ordering, or for any necessary service. The Patent Office will also enter subscriptions for the mailing of such patents as may issue from time to time in a selected sub-class, a small deposit being made and renewed to cover the cost, at five cents each.

DIGESTS.

Over 600,000 United States patents have been issued, and it is unfortunate that the Patent Office has thus far not been able to procure appropriations for digesting them somewhat as the British Patent Office has partially done with its comparatively small number of patents. Such digests of United States patents as have thus far been published are the result of individual enterprise, and the works are necessarily expensive, owing to the great labor and the very limited demand. Manufacturers interested in specific lines of invention would do well to avail themselves of such digests so far as suitable to their purposes. These digests have been the outgrowth of special activity in certain lines of industry at certain times. I have never seen a complete list of these digests, and do not know that one could be made; but I here append a list as complete as I can make it, viz.:

Sewing Machine Attachments. By George W. Gregory. 1872.

Breech Loading and Magazine Small Arms, except Revolvers. By V. K. Stockbridge. 1875.

Seeding Machines and Implements. By James T. Allen. 1878. With certain supplements since.

Plows and Attachments. By James T. Allen. 1883.

Agricultural Implements. By James T. Allen. 1884.

Harrows and Diggers, Seeders and Planters, Cultivators, Harvesters. James T. Allen. 1886.

Cycles or Velocipedes, with Attachments. By James T. Allen. 1892. With certain supplements.

Underground Lines. By James W. See. 1886.

FOREIGN PATENTS.

Good foreign patents are extremely valuable property, but it does not follow that all foreign patents are of value. Not one in a hundred of American inventions, even if they are somewhat profitable, are worth the cost and trouble of foreign patents. The cost of foreign patents is heavy, and in most cases the continued validity of the patents is contingent on the payment of taxes and the local working of the invention. If a customer is promptly found under the foreign

* To be presented at the Niagara Falls meeting (June, 1898) of the American Society of Mechanical Engineers, and forming part of Vol. xix. of the Transactions.

patent, then its taxes and working offer few difficulties; but if no customer is found within a year, it becomes a serious matter to perform the legal working. Little or no confidence should be placed in nominal or paper workings, and even these are expensive. In some countries taxes begin and the invention must be worked at the end of the first year, and the working must not permanently cease; and in the case of Canada the continued validity of the patent restricts the power to import the invention into Canada. An invention which has made good profit in America and is a matter of foreign requirement is well worth foreign patents, and the customer may often be found in view of the American success. But the trouble is that the foreign patenting cannot be delayed until American success determines its expediency. In some foreign countries the patent would be rendered void by prior patenting or disclosure, and in America the patent expires with the term of the first expiring previously granted foreign patent. Hence, to avoid any antedating, all the patents should bear about even date. Date can be made for foreign patents by merely filing the applications, while in America the date of patent is the date of grant, and may be months or even years after the date of application. Hence the proper course is to take no steps regarding foreign patents till the United States application is allowed. Then select the proper future issue day for the United States patent and cause all the foreign applications to be filed on that day. An exception is to be made in case the invention goes into public use before the issue of the United States patent. In such case the shortening of the life of the United States patent must be submitted to, and the foreign patents should be taken out before public disclosures would render them void.

In most foreign countries patents are granted as a matter of course, without examination into novelty, and the grant of the patent is no evidence whatever that the patent is good for anything. In Germany applications are examined, and generally rejected. The merit which will insure the grant of a German patent is not at all to be measured by American standards.

Briefly, then, waste no money on foreign patents unless prompt results are in sight, or unless the invention is of importance enough to justify the expense and trouble due to recurring taxes and legal local working of the invention; foreign patents should antedate invalidating disclosures of the invention; it is desirable that all patents on the same invention bear even date. This latter can be secured by filing the foreign patents in the interval between allowance and grant of the United States patent.

RAPID INTERRUPTERS FOR INDUCTION COILS.

IN order to show the mutual attraction of electric currents flowing parallel with each other in a solenoid, the following experiment, due to Roget, is performed in lecture courses. With a long copper wire, the professor forms a spiral, straightens out a few centimeters of its extremities, and then fixes it to a support in such a way that the lower extremity of the rectilinear part terminating the spiral shall come flush with the surface of a mercury bath. Upon then sending a current through the apparatus (which is done by plunging into the mercury that one of the rheophores which leads the current, while the other is brought into contact with the upper extremity of the spiral), the convolutions are observed to approach each other abruptly and cause an interruption of the contact between the wire and the mercury. The current consequently ceases to pass; but, owing to the elasticity of the spiral, which resumes its prior position, the phenomenon begins again and gives rise to a rapid oscillation of the apparatus.

This experiment of pure demonstration has suggested to us the idea of constructing for induction coils a genuine interrupter as a substitute for the Foucault apparatus, which has been almost exclusively employed up to recent years, but to which the objection is made that it does not operate very regularly and has a speed that in many cases is inadequate for radiographing. An apparatus so simple as is the Roget spiral is capable of rendering the same services as costly and complicated ones, provided that there be introduced into it certain modifications that we suggested to the Geneva Society of Physics and Natural History at its meeting of June 5, 1897. The helix is formed of a limited number of spirals of coarse copper wire, and is placed in its entirety in the interior of a test glass or of a simple bottle with a wide neck. The lower extremity of the helix is straightened for six or eight centimeters of its length and dips into some mercury placed at the bottom of the bottle and covered with a layer of water.

The upper extremity of the spiral is fixed to a cork which tightly closes the bottle. The cork is traversed also by a copper rod that leads the current to the mercury, and thence to the spiral, and through a bar of soft iron that may be inserted more or less completely into the spiral. In order to avoid heating, the whole may be placed in a second vessel entirely full of water.

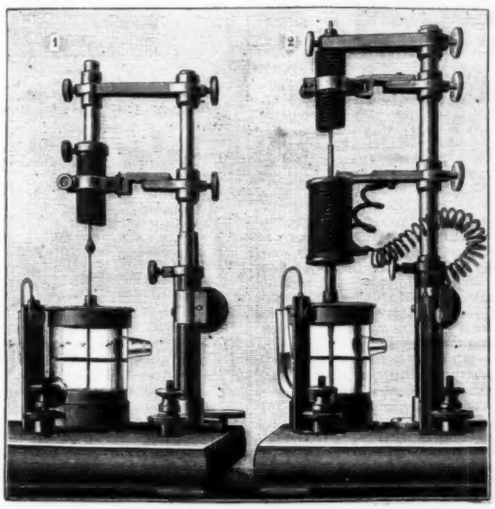
The operation of this interrupter is very simple and differs in no wise from that of the ordinary spiral. The object of the presence of the bar of soft iron is to give greater amplitude to the oscillations, without having any influence upon their rapidity. Such amplitude may reach two centimeters and beyond with the intense currents of from fifteen to twenty amperes that the operation of large induction coils requires. As the velocity of oscillation of the spiral depends upon the diameter of the copper wire, upon its transverse dimensions, and upon the number of convolutions, the size most appropriate for any given induction coil may easily be found.

As an example, we may mention the Ruhmkorff coil owned by the University of Geneva, which operates normally with a twenty ampere current and gives sparks of from twenty to twenty-five centimeters. The interrupter that we have adapted to this has given very satisfactory results in the illumination of Roentgen tubes, and in the Tesla experiments, etc. It is formed of a helix of fifteen convolutions having a width of twenty-four millimeters for a wire diameter of one and five-tenths millimeters. The convolutions themselves are separated from each other by an interval of about one millimeter.

This little apparatus, which any one can construct for himself in a few minutes, may be rendered more practical by adapting to it the arrangements employed in other interrupters, and among these the commutator indispensable for changing the direction of the current, and a screw and rack for conveniently changing the contact of the extremity of the copper wire with the mercury. On another hand it is advantageous to modify, in a certain measure, the rapidity of the oscillations. This may be done by adapting to the apparatus a clamp for making it possible, at will, to render a certain number of the convolutions immovable, as shown in Fig. 1.

A second form of interrupter, shown in Fig. 2, gives a still greater rapidity of oscillation; but the construction of it is not so simple as that of the apparatus just described. The operation is the reverse of that of the former, that is to say, the copper spiral is stationary, while the rod of soft iron is free to move in its interior. In order to give this form of interrupter greater energy, the spiral becomes a true electromagnet. One of the extremities of the iron rod extends beyond the lower part of the coil, while the other reaches only to the central part. Contact with the mercury is effected through a copper or platinum point screwed into the iron. The upper extremity of the iron bar is soldered to a copper rod that is converted into a spiral in the part situated above the magnetizing helix. Although traversed by the current, this spiral acts especially, by virtue of its elasticity, as a counter spring in order to re-establish the contact with the mercury when, under the energetic action of the current, the bar is raised in the interior of the electromagnet. This interrupter may be easily constructed in such a way as to give rapidity and amplitude to the oscillations. If we select a strong spring formed of only a dozen convolutions of coarse copper wire of from two to three millimeters diameter, the attraction of the soft iron in the interior of a solenoid traversed by intense currents acts very energetically toward depressing the spring, which, in turn, reacts very vigorously when the current ceases.

Platinum is generally used for establishing the contacts in mercury interrupters; but the use of this costly metal can be dispensed with, without inconvenience. Copper, as we know, does not dissolve in mercury to any appreciable degree, and so we may use it in lieu of platinum for producing the interruption of the current. Although, in the long run, this metal becomes covered with a layer of verdigris, this slight defect is largely compensated for by an electric conductivity that is much superior to that of platinum, through the elimination of soldering with iron or copper or of defective contacts that become heated.—C. Margot, in La Nature.



1. ELECTRO-MAGNETIC INTERRUPTER FOR INDUCTION COILS. 2. ELECTRO-DYNAMIC INTERRUPTER.

ELECTRIC RAILROADS IN SEOUL.

HORACE N. ALLEN, United States consul in Seoul, writes to the State Department as follows:

"I have the honor to inform you that a company has been formed in the city of Seoul for lighting the streets and residences with electricity and for operating electric street railroads through the principal thoroughfares. Only the latter will be begun at once.

"The company, known as the Seoul Electric Company, is composed entirely of Koreans, with the governor of the city as president. They have an exclusive franchise from the Department of Public Works, Agriculture and Commerce, and have paid in about one-half the capital of $300,000.

"This company has made a contract with Mr. H. Collbran, of Denver, the American contractor for the construction of the Seoul-Chemulpo Railroad, for the construction and equipment of an electric trolley street railroad of the latest and most improved design. The railroad will be about 6 miles in length, and will run from the station of the Seoul-Chemulpo Railroad, through the south gate of the city, along the broad streets, past the new palace and foreign quarter, through the busiest part of the city and the great east gate, to the tomb of the empress.

"Mr. Collbran has received a cash payment of $100,000 with his contract, and the work will be rapidly prosecuted.

"It is regarded as a profitable enterprise, since, with a city of 300,000 people and no amusements, there will probably be enough passenger traffic from curiosity seekers to make it pay for a year or so, while the people are being educated to the point of regarding the road as a necessity.

"At present, all the financial ventures of importance in Korea are in the hands of Americans."

BARK AND CORK.

THE Pennsylvania Department of Agriculture set apart a portion of its appropriation last year for investigations by men of science in those branches of knowledge that might have a practical bearing on the progress of agriculture, says The Independent. These papers are issued in "Bulletins." No. 29 of the series is on the bark of trees, and is from the pen of the State botanist, and gives some wholly new points in relation to the office performed by cork in the economy of tree life. The author starts on the proposition that the wisdom of nature is not confined to development. Destruction is equally wisely provided for. Cork is one of the agencies so wisely provided for the destruction of vegetable tissues.

When a branch of a tree is cut off during the growing season the leaves die black or brown, but remain attached to the branches. But when they remain on till the period of the fall of the leaf, cork is formed, and just at this point the leaf is detached from the branch. So of branches themselves. Innumerable branchlets are formed—more than desired for the permanent frame of the tree—and cork is called in to throw of the superfluous twigs. This is exemplified strikingly in cedar and arbor-vitæ trees. But it is in the bark of trees that the most remarkable development of cork is noted. The variations in the bark of trees are almost as numerous as in those characters known as specific differences. Scarcely any two trees excorticate alike. In some it peels off in flakes, as in the apple and the buttonwood; in others it presents sheets, as in the cherry and the birches; while in others it is rough as rough can be, as in some oaks, ashes, persimmons and other familiar trees. These again subdivide, and the roughness in the bark of one oak differs from the roughness of another. Each tree, in fact, has its bark peculiarities so marked that one who has made a study of the subject may identify most trees, though he be blindfolded, by simply feeling the trunk of the tree.

The author shows that this could not be the case if the rifts of trees came about by mere mechanical pressure, resulting from the increasing thickness of the trunk. When twigs are first formed, small dots appear on the surface of the bark. In some species they are scarcely visible, in others they are so prominent as to give the twig a warty appearance. These are the latent cork cells. But their final development varies in different species of trees. When they do, the development is specific in each case. Sometimes they develop laterally, as in the birch and cherry. When they meet each other, the time of separation is complete, and we have the sheetlike character of the birch and cherry. When they meet each other in a vertical direction, we have the usual rough fissure; and they develop beneath the surface when the flaky pieces of the buttonwood and shell bark are formed. An apple, which is but a modified branch, has imperfectly developed cork cells. These do not often advance, and so we have smooth apples; but they are occasionally called into activity, and then we have russets.

In short, the main office of cork in the economy of plant life is to aid nature in getting rid of that for which she has no longer any use. Bark has an expansive power. It will stretch. The lacebark tree of Jamaica is used in illustration. In our linden and sweet chestnut it will stretch sufficiently to present what is known as smooth bark for a number of years. The cork cells continue inactive; but as soon as the limit of expansion is reached, the latent cork cells spring to action. They rift the old bark, and it is thrown off. The practical lesson is deduced that the cultivator must help nature, either by helping, by washes, to continue the natural stretching of the bark or to throw off the old scaly bark when the full office of live bark has been exercised. In these operations, as in others, nature seems at times to be working exuberantly. More effort seems thrown in certain directions than the mere good of the individual requires. It seems as if the good of other things were being kept in view at the same time. In this case we have the cork layers of the oak and corky wings of the sweet gum—all far in excess of individual needs.

APPARATUS FOR THE PRODUCTION OF ACETYLENE GAS.

ACETYLENE apparatus with automatic distribution for the fall of the carbide into the water answers very well for installations in which the number of the burners to be supplied is relatively limited. They should operate automatically without getting out of order or without its being possible for them, if they should get out of order, to give rise to a dangerous overproduction. By their very nature, these apparatus are therefore designed to be run without any surveillance.

But, as soon as the installation becomes important and it is a question of assuring the supply of several hundred burners, the conditions become different.

Just as in the case where there are a hundred kerosene lamps, it requires a permanent lamp lighter to do the cleaning, keeping in order, and lighting and extinguishing; and just as in all electric works comprising

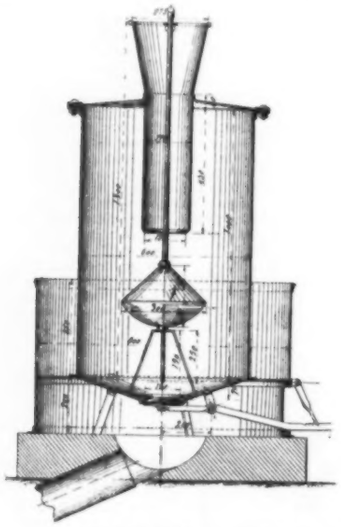


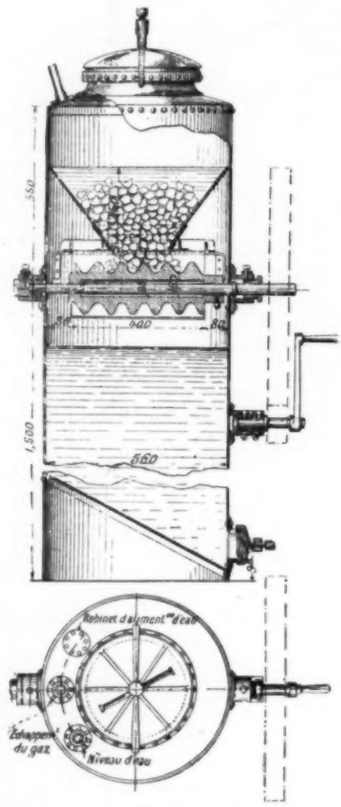
FIG. 1.—GAS GENERATOR OF THE SOCIÉTÉ DU GAZ ACETYLENE.

generators of force and electricity, one man, and sometimes several men, are necessary for the service, so in every large installation of acetylene one man at least is required to look after the operation of the apparatus. In the majority of cases any employe whatever may take charge of the apparatus and do other work besides. The principle of automaticity may then be abandoned, and be replaced by the work of a man, whose presence will be requisite only for a few instants, say at the moment when it becomes necessary to introduce into the apparatus the quantity of carbide required for the production of new quantities of acetylene. Automaticity in a large industrial installation becomes useless, cumbersome and costly, and maneuvering by hand is much more simple and convenient. In this order of ideas, we shall describe two types of apparatus, one of which has been in operation for two years and the other is in course of installation.

1. Industrial Apparatus of the Société du Gaz Acetylene.—This apparatus has been installed in the works of Mr. Ollier, at Courneuve, near Paris, which give a production of 210 cubic feet an hour. It is represented in Figs. 1 and 2.

The generator consists of a cylindrical receptacle of galvanized iron closed at the top by a cover fixed by means of bolts. For a third of its height it is inclosed in a cooling cylinder filled with water. To the center of the cover is fixed a charging tube, which widens out at the top into the form of a funnel. A hollow cone, forming a float mounted upon a rod guided at its two extremities, is capable of moving vertically in the direction of the axis of the tube and of placing itself against the lower edge of the charging tube, which it slightly exceeds in width. The rod of this float carries a maneuvering handle.

Two gage cocks are arranged upon the generator for showing the height of the water in the interior. A delivery cock of wide section is mounted upon the cover.



FIGS. 3 AND 4.—LUCHAIRE APPARATUS.

The bottom of the generator is conical, and terminates in a clearance valve with a large orifice that permits of the easy exit of the residua.

The maneuvering is exceedingly simple. The apparatus having been filled with water to two-thirds of its height, the float places itself against the bottom of the charging tube, and prevents the exit through the latter of the bubbles of gas disengaged in the generator. The float is lowered by hand in order to open the charging tube, and one or more shovelfuls of carbide are thrown into the latter through the funnel, and the float is then allowed to resume its former position.

The charging tube forms a hydraulic joint, on the surface of which is placed a stratum of kerosene or oil, the effect of which is to suppress the disengagement of the gas during the passage through the carbide of the column of water contained in the tube. It performs, in addition, the role of a safety valve.

The number of generators used varies with the importance of the installation. The carbide is shoveled into each of them, just as coal is shoveled into a furnace. The gas produced passes through a series of condensing, refrigerating and purifying apparatus and flows to a gasometer, of which the dimensions in certain installations exceed 350 cubic meters.

The gas upon making its exit from the generators passes first into a worm, wherein it abandons, through condensation, a portion of its aqueous vapor and its impurities, then into a purifier designed to arrest the phosphureted and sulphureted hydrogen, and finally into the gasometer. Upon making its exit from the latter, it passes through a drier, and next through a return flame extinguishing apparatus, and then enters either a meter or the conduit.

When the holder of the gasometer has nearly reached the end of its downward travel, it comes into contact with an electric device that sets in motion a bell which does not cease ringing until the holder reascends after a new charge.

One or two pailfuls of residua are removed every day and are replaced by clean water poured in through the charging tube.

From the viewpoint of the manufacture of acetylene, these arrangements present a genuine simplification.

2. The Luchaire Apparatus.—This apparatus (Figs. 3 and 4) consists of a cylinder closed at the top by a cover fastened down with a bridge and bolt. Upon the dome there are three cocks, one for the escape of the gas, one for the entrance of water and one for the water level. Immediately beneath the cover there is a hopper into which the carbide is thrown, and at the base of the hopper there is a compartment containing a screw which may be maneuvered by hand through a train of cogwheels. The space beneath this compartment is filled with water up to within two inches of the latter. The apparatus operates as follows:

The lower part of the cylinder is filled with water, and then carbide is thrown into the hopper and the cover is bolted down. When the crank is turned, the pieces of carbide are carried along by the endless screw to the extremity of the compartment and fall into the water.

The acetylene formed escapes from the generator through the delivery cock and reaches the bottom of the gasometer, where it passes upward through the water into the holder.

After the supply of carbide is exhausted, it suffices to open the water feed cock. The water is supplied by a reservoir that gives a pressure slightly greater than that of the gas in the holder, and therefore completely fills the generator in driving the gas before it. After the generator has become full of water (a fact that may be known from the tube of the level), the gas discharge cock and water feed cock are closed. Then, after the cover has been removed, the clearance valve at the bottom is opened. All the water charged with lime will in the first place flow out and the removal of the balance will cease after the level of the liquid has reached its habitual place beneath the screw compartment. The operation will then be resumed.

This apparatus, like the preceding, may therefore be used for large productions of gas, and be employed either for obtaining gas under pressure or gas designed for the lighting of extensive establishments or of cities; in a word, for important installations. For the above particulars and for the illustrations we are indebted to Le Genie Civil.

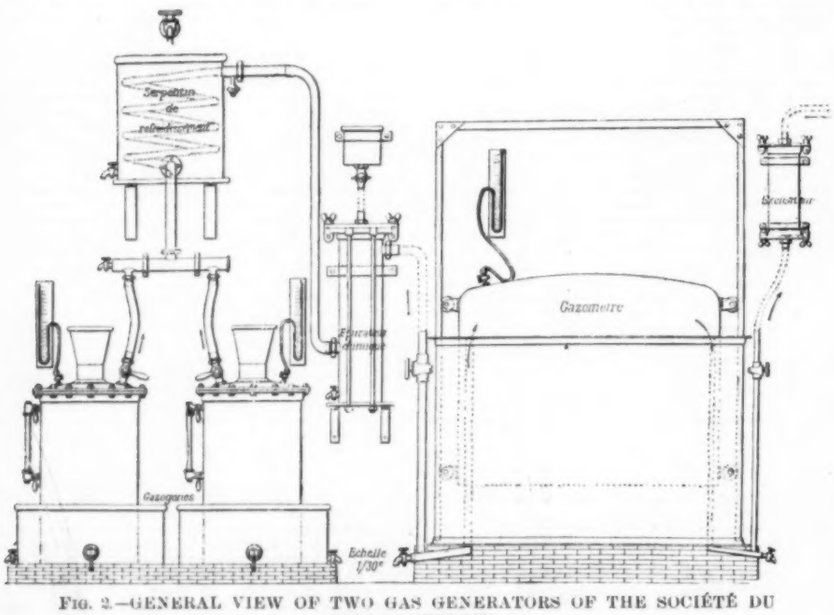


FIG. 2.—GENERAL VIEW OF TWO GAS GENERATORS OF THE SOCIÉTÉ DU GAZ ACETYLENE.

CONCERNING ROPE.

SHIPS use great quantities of Manila rope, says The Marine Review. The manufacturers of rope and the ship chandlers of the country were therefore very much interested in market conditions pertaining to this article long before there was any certainty of hostilities between Spain and the United States. About a year ago an insurrection was expected in the Philippine Islands, and immense quantities of hemp were shipped to Europe and this country. The manufacturers of rope are said to have lost a great deal of money on this operation, but the effect of it was to reduce supplies of the fiber from the Philippines. Now comes the war with Spain and the advance in Manila rope, said to be due as much to short supplies of hemp as to the fear of a long continuance of the war. All the fiber which is made into Manila rope comes from the Philippine Islands. The plant resembles the banana. It grows from seeds and also from shoots or suckers, often to the height of 20 to 25 feet, having a tuft of leaves only at the top. It is difficult for those who live in temperate climes to realize the rank growth of tropical vegetation. When properly matured, the leaves are peeled off down to the bottom of the tree. The fiber is then separated, dried and cleaned, and tied in hanks, being from 10 to 15 feet in length; these, in their turn, are put in bales of 270 pounds, in which shape the material is shipped to Europe and America for manufacture into rope and binder twine. The importation of Manila hemp into the United States during 1897 was 123,349,500 pounds.

The fiber called Sisal is from a plant that grows in a wider extent of territory, but the best and most profitable country for its cultivation is Yucatan, now part of Mexico. The importation of Sisal into the United States in 1897 was 118,601,280 pounds, and of New Zealand hemp 903,690 pounds.

In manufacturing a rope, the fibers are first spun into a yarn, this yarn being twisted in a direction called "right hand." A number of these yarns are then twisted "left hand" into a strand. Three or four of these strands are then twisted "right hand" into a now completed rope. As the strand is twisted it tends to untwist the threads, and as the rope is twisted it tends to untwist the strands, but to retwist the threads. It is this opposite twist that tends to keep the rope in its proper form. When a weight is hung on the end of a rope, the tendency is for the rope to untwist and become longer. In untwisting the rope it would twist the threads up, and the weight will revolve until the strain of the untwisting strands just equals the strain of the threads being twisted tighter. In making a new rope it is impossible to make these strains exactly balance one another. It is this fact that makes it necessary to take out the "turns" in a new rope, that is, untwist it when it is put at work. The greater the twist in a new rope, the better it will keep its form, but it is not quite as strong, because the fibers are strongest in the direction of their length, and the greater the angle of the fibers, due to

the twist of the strand, the less is their resistance in the direction of the center line of the rope. In bending over a sheave or drum, the rough fibers slide over each other while under pressure from the load, causing internal chafing and wear. Open an old rope by untwisting the strands, and a fine powder will drop out, due to the cause just mentioned. The larger the sheave, therefore, the greater the life of the rope.

LIQUEFIED AIR FOR INDUSTRIAL PURPOSES.

SINCE the historic date of December 24, 1877, at which M. Pictet and M. Cailletet announced simultaneously and independently to the Academy of Sciences that they had succeeded in liquefying oxygen, numerous researches have been made in various quarters with a view to simplifying the processes and increasing the quantity produced.

We have followed these researches step by step and have at different times noted in these pages the progress made in the important question of the liquefaction of gases reputed to be stable; and, as long ago as the month of November, 1895, we made known the processes employed by Dr. Linde, of Munich, who had succeeded in liquefying air without having recourse to any other method of cooling than the expansion of the air itself.

The improved apparatus used for this purpose are now in daily service in a certain number of laboratories, and the industries are beginning to take them up with a view to applications of which it is as yet difficult to limit and even foresee the development. The moment, therefore, seems to us opportune to furnish more complete data as to this improved apparatus, derived from an interesting lecture delivered by Prof. J. A. Ewing last March before the Society of Arts.

The principle of Dr. Linde's apparatus is based upon the fact that the expansion of a gas through an orifice is accompanied with a lowering of the temperature so much the greater in proportion as such gas is less perfect, that is to say, in proportion as it more nearly approaches its point of liquefaction and thus constitutes a vapor. With a gas theoretically perfect, the cooling would be nil, since it effects no work capable of removing from it a corresponding quantity of heat. Joule and Lord Kelvin have found that, at the ordinary temperature, the reduction of temperature obtained by the expansion of air is about a quarter of a degree per atmosphere. This suffices for the beginning of the operation, since, in the Linde apparatus, such reduction is utilized for cooling the point at which the expansion is effected, and for producing the latter at a lower temperature, and so on indefinitely until liquefaction occurs, if care has been taken to prevent the heating of the part of the apparatus in which the air expands.

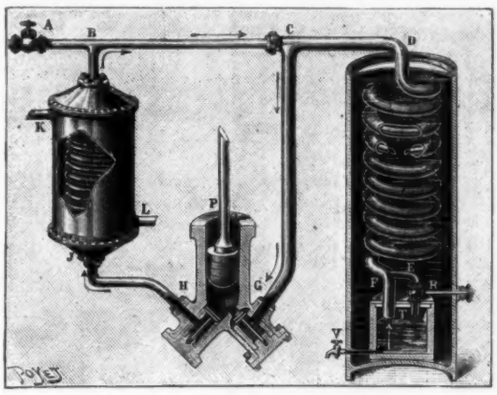


FIG. 1.—APPARATUS FOR LIQUEFYING AIR.

The apparatus that realizes such conditions, reduced to its essential parts, is represented in Fig. 1. It consists of a compressor, the piston, P, of which produces air at a high pressure and sends it to a cooling worm, L, with a circulation of water at K L, for depriving the air of the heat developed by the compression. This air at a high pressure enters the interior tube of a double worm, D E, in which occurs an exchange of temperature; for, after having expanded at R, the air ascends at F and returns to the compression pump through the external tube of the worm. The cooling produced by the expansion serves to lower the temperature of the air entering at R, so that the temperature at R and T becomes lower and lower until the liquefied air falls into the reservoir upon which the extremities of the two worms are mounted. A cock, V, serves for drawing the liquid air from the reservoir. An auxiliary pump connected with the point, A, serves for compensating for leakages, and likewise for renewing the part of the air liquefied in the reservoir, T.

If we call the pressure of the air before the expansion P_1, and its pressure after expansion P_2, the fall in temperature produced by such expansion will be proportional to $(P_1 - P_2)$, while the work expended by the pump in order to raise the air from a pressure, P_2, to a pressure, P_1, will be proportional to the ratio $\frac{P_1}{P_2}$. It is, therefore, necessary to at once render the difference in pressures as great as possible and their ratio as small as possible. In order to satisfy these two conditions, Dr. Linde makes $P_1 = 300$ atmospheres and $P_2 = 50$. In order to obtain a given quantity of liquid air, we thus use three times less work than if the expansion were pushed to the pressure of the atmosphere. This figure shows how important it is to keep the pressure, P_2, quite high, after a normal operation is reached and the apparatus is working in a continuous manner. Only the liquid itself must be allowed to escape at the pressure of the atmosphere. It is in order to obtain such a result that Dr. Linde has modified the apparatus just described and produced the laboratory type shown in Fig. 2. This apparatus comprises two pump chambers and a triple exchanging worm inclosed in a wooden box filled with wool in order to prevent radiation of heat to as great a degree as possible. The air, compressed to 200 atmospheres, traverses the internal tube of the triple worm and reaches the expansion chamber, a, which it traverses; but a fifth only of the air thus expanded traverses the second expansion chamber, b, before entering the tube that puts it in communication with the vessel with double jacket, c. After its expansion at a to 16 atmospheres, the air ascends through the intermediate worm and returns to the pump in order to be compressed anew. The part expanded to 16 atmospheres at b, at a pressure scarcely greater than that of the atmosphere, traverses the external tube of the worm and escapes into the air. The pressure in the vessel, c, is just great enough to allow the liquefied air to enter it through the tube, h, forming a siphon. After the normal operation is established, about a quarter of this air is liquefied.

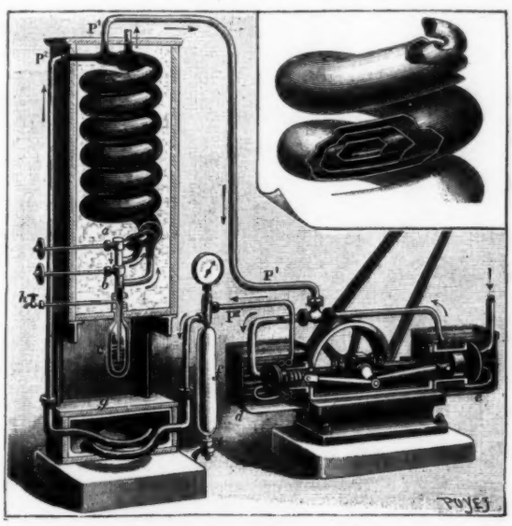


FIG. 2.—LABORATORY APPARATUS.

The object of the pump chamber, e, is to extract pure air from the atmosphere, to compress it to 16 atmospheres, and to mix it with the air derived from the first expansion after traversing the intermediate worm.

The second pump, d, compresses the air to from 16 to 200 atmospheres. Upon making its exit from each of these pumps, the air traverses a worm immersed in water and becomes cooled therein.

The air compressed by the pumps contains a little water injected for the cooling. It becomes partially dry in a separatory, f, and then in a worm, g, surrounded by a bath of ice and salt.

This apparatus produces about 28 ounces of liquefied air per hour with an expenditure of 3 horse power to actuate the pumps.

A large model, based upon the same principle and designed for industrial purposes, has been studied for the production of about 12 gallons per hour with the use of 120 horse power.

These figures prove that the manufacture of liquid air has now entered an industrial phase.

For the above particulars and the illustrations we are indebted to La Nature.

ACTION OF SEA WATER ON CAST IRON.

IN the Archives de Médecine Navale et Colonale, of last June, Le Navur reports upon an interesting find of some old cast iron projectiles, made during hydraulic operations on the shore of Brest. The projectiles evidently come from a shipwreck, to which Le Navur, without going further into his reasons, assigns the date of either 1745 or 1791; he leaves the historical part of the research to others. In any case the projectiles would have been over a hundred years in the sea water. The outside crust consisted of a siliceous and calcareous deposit and iron oxide; the oak plug was well preserved; the powder formed a cake of sulphur and carbon, in which—in most cases—no trace of nitrate could be discovered. The iron under the rusty crust was, to all appearance, in a good state of preservation; but it had a specific gravity of 3·1 only, was soft, could be cut with a knife, and was so eager to combine with oxygen that a thermometer, placed in the mass, spontaneously rose to 185° Fah. Under the microscope one noticed metallic particles coated with a greenish mass, which soon became brown by oxidation.

On account of this rapid oxidation, and because hydrochloric acid developed sulphureted hydrogen, Le Navur thought that iron sulphide had been formed with the help of the sulphur from the powder, or from organically reduced sulphates. But the disintegration had clearly proceeded from the outside, and the percentage of sulphur found was too insignificant to sustain this view. The analysis yielded in per cent.: Iron, free 56, combined 12, carbon 13, silicon 2·5, sulphur 0·325, chlorine 1·75; as in another part of the paper 2·6 per cent. of sulphur was spoken of, there is possibly a misprint in the sulphur figures.

The high percentage of carbon and the low percentage of iron are the most striking features, and, indeed, very suggestive. Analyses made in the United States—first, if we remember rightly, by Rigge, in Omaha—of iron conduits, corroded by leakage currents from electric tramways, show the same peculiarity. The pipes did not appear to have suffered much, but they looked pitted, and nodules could be taken out, which contained little iron and much carbon, suggesting a gradual dissolution of the metallic particles by electrolytic action, which left the insoluble constituents behind.

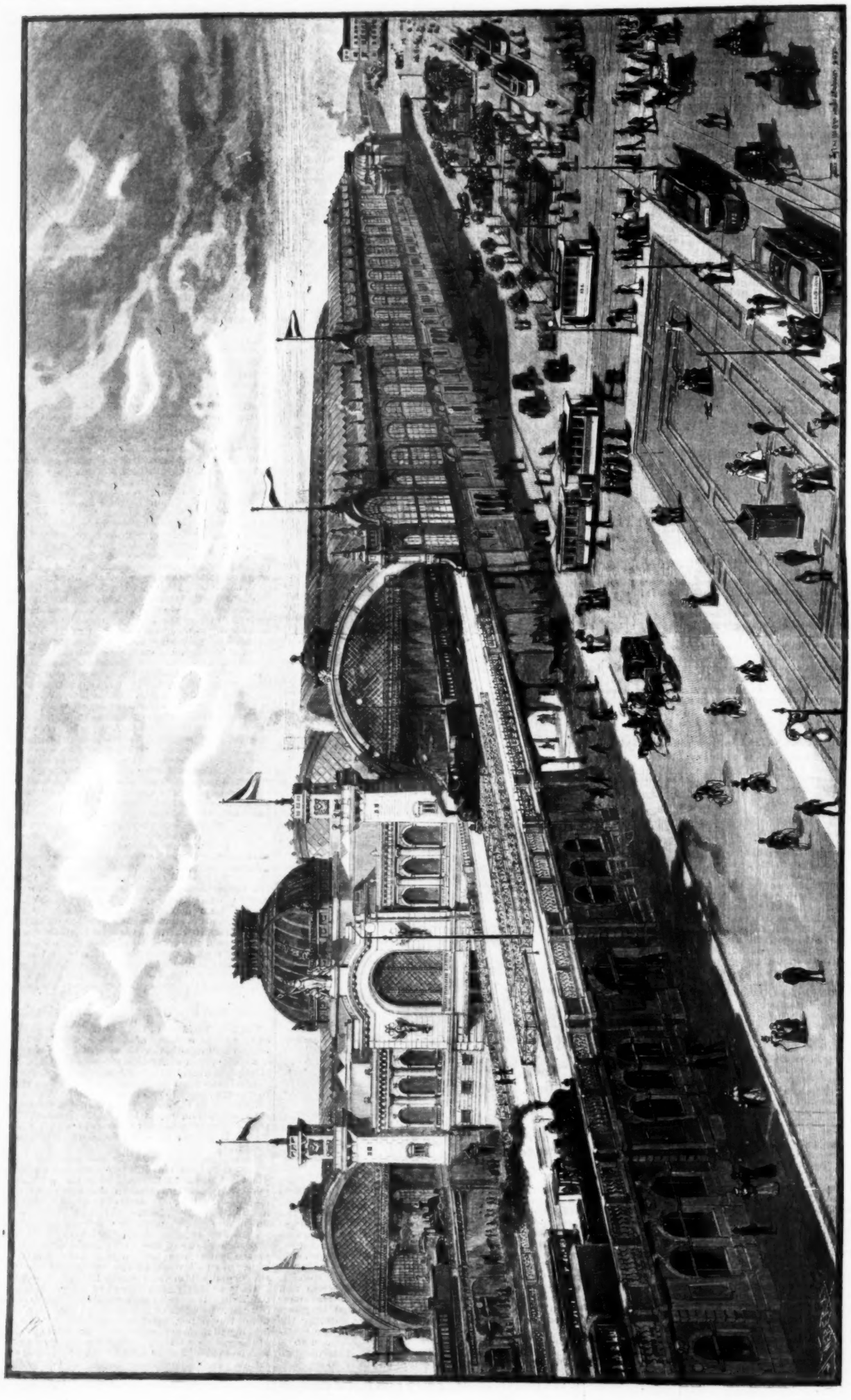
Le Navur makes no allusion to this circumstance, but he also assumes electrolytic action, combined probably with chemical reaction, and he refers to the electrolytic determination of carbon in cast iron. His suggestion is that the electromotive force of the iron carbon couple decomposed the sodium chloride of the sea water; the chlorine attacked and dissolved the iron; the sodium generated hydrogen, which provided that reducing atmosphere which the continuation of the process required; the hydrogen bubbles would, moreover, loosen the iron, which would thus become soft, and might also reduce the sulphates of the sea water. Owing to the presence of hydrogen, the iron would further preserve that deceiving bright appearance which may mislead the inspecting engineer.—Engineering.

NOVEL GAS LEAK DETECTOR.

CONSUL MORRIS, of Ghent, says: The outfit for detecting leaks consists of a large hand drill or auger, several hollow tubes or pipes of the requisite length, a few corks fitted with quills through the center, a bottle of or-palladium, and a few bits of white paper.

The tubes must be long enough to enter the ground to a point about 15 to 20 inches above the main and to project above the street pavement a sufficient distance for observation, say 3 to 4 feet. They may be iron, such as common interior gas pipe, or, better still, brass, which is lighter to carry and more convenient to handle.

Several paving blocks are first removed for a space of about 2 yards immediately over the gas main, and holes are bored in the soil with the drill, care being taken to thoroughly loosen the earth and extract as much as possible. In each of these holes a piece of the hollow piping is planted. It should not be rammed down too deep, so as to be too near or below the gas main or to become clogged with dirt. On the upper exposed end one of the corks is placed, with the quill in the center running up and down parallel to the pipe. A small piece of the white paper is dipped in the or-palladium and pushed into the open quill. Twenty or thirty such detectors are put in position at one time. If a leak exists within say two yards of any of them, the effect of the escaping gas will be evident upon the paper, rendered sensitive by the reagent, and it will at once turn black. The effect of the action of the gas upon the detector first placed in position will be evident before the last one of a row of twenty is set up. It is a common sight to see two or three men in the streets of Ghent making experiments in this manner for the detection of leaks. Indeed, the gas



THE NEW PASSENGER STATION IN DRESDEN.—BUILT BY GIESE & WEIDNER.

company causes regular tests to be made in turn in all the streets of the city. The loss by leakage is now said not to exceed more than three per cent.

THE NEW RAILROAD STATION IN DRESDEN.

THE history of the new railroad station in Dresden extends back to the seventies, when the great advance in all German industries caused an increase of the railroad and street traffic at the capital of Saxony, which was spreading rapidly toward its suburbs. The inadequacy of the railroads became more and more evident, the grade crossings were very dangerous, and it was decided that there must be a complete change of system. The problem was considered for several years, but, finally, its solution was simplified by the acquisition of the Berlin-Zossen-Dresden Railroad—or, at least, that part of it that runs over Saxon territory—by the state, and in 1891 the partial plans of the proposed arrangement were laid before the Ständeversammlung, which accepted them and appropriated $8,460,000 for carrying them out. The work was promptly and energetically begun, but it was afterward found necessary to make considerable alterations in the plans on account of the constant increase in the city, and so that the new arrangement might meet the requirements of the constantly increasing traffic for a long time to come; therefore, the Ständeversammlung increased the appropriation to about $14,232,000; $4,365,000 of this sum was used for the passenger station, yards, etc., which extend more than a mile, while the buildings for the reception of trains and passengers cost nearly $2,000,000. This imposing structure, a view of which we publish to-day, was designed by the well known Dresden firm of architects, Giese & Weidner, who entered the competition of German architects and were awarded the first prize for their design. A like prize was received by the Leipsic architect, Dr. Arwed Rossbach, whose plans were not, however, used, for various reasons. The greatest difficulty the competing architects had to contend with—aside from the multiplicity of uses for which the structure was destined—was the relation of the road to the main course of city traffic, Prager Strasse, which it crosses; but this problem was most skillfully treated by Giese & Weidner. In finishing the interior, none of the latest improvements were, of course, omitted. The model which the constructors had constantly in mind was the fine station in Frankfort, which still, in many respects, ranks first among such structures.

The station is divided into three parts. A large central car house, which is open from the level of the street, and two other car houses, one on each side of the central one, which are raised 16 feet above the level of the street. The central house is 197 feet wide and 610 feet long, and terminates at the Prager Strasse end in a reception building. This part of the station is intended for a main station for roads running to and from Breslau and Munich and for all trains to and from the suburbs through which those roads pass. The house on the south side, or the "Südhalle," as it is called, is devoted to trains running to Vienna and from Leipsic and Berlin and the suburbs through which they pass, while the north house, or "Nordhalle," is to be used for trains running on the same roads, but in opposite directions. These tracks, which are used for through trains, have been elevated, so that the only grade crossing is at the river, and, consequently, there is no danger of collisions with the street railroads.

The base of the structure is massive, but the upper part is of iron and gives to the whole a light and airy effect, which is heightened by the fresh tone of the paint. The view of the interior from the dome-crowned reception building at the end of the central house makes a most imposing picture, life and color being given to the whole by the artistic arrangement of details. The coats-of-arms, in heraldic colors, of twenty-six cities of the kingdom ornament the arches, while the wall of the dome is decorated with flowers, foliage and emblematic subjects. Everything possible is done for the comfort of travelers. On each platform there are restaurants that can be entered from the platforms and also from the interior; while the reception building is provided with spacious waiting rooms, which are decorated with beautiful porcelain tile paintings from the Meissen works made after designs by the famous Prof. Julius Sturm. The ticket offices and baggage rooms are in the reception building. There is, of course, no lack of toilet rooms, barbers' shops, money exchanges, post offices, telegraph offices, etc.

Over the central entrance there is a fine colossal group by Prof. Rentsch, the central figure of which represents Saxonia, with the scepter and shield, and at her right and left are figures representing Science and Technology. On each side of the entrance is an idealized bronze figure by the Dresden sculptor Albert Starke. These figures, which are 16 feet 4 inches high, serve as lantern holders.

This fine structure was completed in two and a half years, thanks to the energy and discretion of Mr. Peters, one of the officers of the road, and in spite of the fact that the regular business of the roads was carried on as usual. Dresden may well be proud of this fine structure, which is a sure proof that she is not falling behind, but is progressing with the rest of the world.—Illustrirte Zeitung.

AN HISTORICAL MEDAL.

WE are indebted to The London Graphic for an engraving of a medal of Queen Elizabeth, forming part of the collection of the late T. M. Whitehead, of London. The medal was recently sold at auction in London for £43. It is a fine oval plate of Queen Elizabeth in silver, exquisitely executed by Simon Passe, and depicts the bust of the queen crowned three-quarters right, with hair curled and richly jeweled, ruff erect, open in front, necklace and earrings, and puffed and jeweled gown. On the reverse are the royal arms within the garter crowned, and supported by the lion and dragon; above is the motto, "Diev et mon Droit," and below, on a tablet, "Qui. leo. de. iuda est. et. flos. de. iesse. leones. protegat. et. flores Elizabetha Tvos." The portrait on this plate is taken from a miniature by Isaac Oliver, and the queen is in the dress that she wore when she went in state to St. Paul's after the defeat of the Spanish Armada. The inscription is said to have been the impromptu production of a Westminster scholar, Elizabeth herself having proposed her armorial bearings as the subject of an epigram. Another scholar deserved much credit for his prompt translation:

OBVERSE

REVERSE

THE QUEEN ELIZABETH SILVER MEDALLION.

"May Judah's lion and the root of Jesse
Protect thy lions and thy flowers, sweet Bess."

DON CARLOS.

IT is well known that Spain, while involved in a foreign war which endangers all her foreign possessions, may have to face as well a civil war at home. Nominally, all political parties are united in supporting the government, but the republicans, the Weylerites and the Carlists are disturbing elements which, in the event of a new disaster, may overthrow the present Bourbon rule.

Ever since the time of Napoleon I. Spain has suffered much by insurrections. The guerrilla war to resist the French invasion lasted six years, and ended only with Napoleon's downfall. The Bourbons then returned to the throne, but their rule was not a happy one. The army was unruly, and at the very time Spain was waging the fight to retain her American colonies a military insurrection had to be quelled in the mother country (1821). The reign of Queen Isabella (1833 to 1868) was long but not peaceful. Don Carlos, son of Charles IV. (1788–1808), the king deposed by Napoleon, was in 1830 excluded from the succession to the throne in favor of Isabella. He did not give up his claims to the crown, however, and attempted to gain recognition by the force of arms. For seven years (1833–1840) he fought Isabella's armies, but at last he abandoned the field and in 1845 he renounced all claims to the Spanish throne. He died in Trieste (Austria) in 1855. His son, Carlos, Count of Montemolin, did not interfere actively in Spain, and died, also in Trieste, in 1861. Another son, Don Juan, was the father of the present pretender, Don Carlos. In 1868 Isabella was dethroned; Don Juan gave up his claim to the throne, but Don Carlos, who was then twenty years old, protested against the republican government established in Spain and against all the governments which have followed it since. The first republic lasted but two years—1868–1870. The Duke of Aosta, an Italian prince, then ascended the Spanish throne. During his short reign (1870–1873) Don Carlos endeavored to establish himself in lieu of the foreign ruler; civil war broke out in 1872. In 1873 Amadeus, Duke of Aosta, abdicated, and once more the republicans ruled for two years (1873–1875). The Bourbons then again occupied the throne, Alphonso XII., father of the present king, reigning from 1875 till 1885. The Carlist war lasted till 1876, when Don Carlos was compelled to leave Spain. He has since lived chiefly in England and lately in Venice, Italy. He was married twice, first in 1867, to Marguerite, Princess of Bourbon-Parma, and the second time in 1894, to Marie Berthe, Princess of Rohan. He has five daughters and one son. The eldest daughter, Blanche of Castile, is married to Archduke Leopold Salvator, of Austria-Toscana. Another daughter of Don Carlos caused considerable gossip recently by eloping with a Roman painter.

The lately reported movements of Don Carlos clearly show that he is prepared to reassert his rights to the Spanish throne if the occasion should prove favorable. He has expressed himself in favor of vigorous action against the United States, no armistice for the Cuban rebels, no concessions, no leniency, as he said to a correspondent of the Paris Matin. He then left Venice, proceeding to Ostend, probably to confer with the leaders of the Carlist party in England. The position of Don Carlos will appear very clearly from a letter which he wrote to one of his supporters in the Spanish Cortes and which was published before war was declared: "On the frontier of the country of Navarra, which has elected you as its representative to the Cortes, I had the sorrow of leaving Spain; but I told you I would come back. Perhaps the hour is near when I shall fulfill this promise. If at Madrid they take up the challenge which has been thrown in Spain's face from Washington, I shall continue to give the same example of abnegation which I have given hitherto, being very sorry I cannot take part in the fight except by the votes I control and by the influence of my name. I shall consider that Carlists will serve my cause if they enlist to go to war with the United States, whoever may be the com-

DON CARLOS.

mander who will lead them. If, however, as everything leads me to fear, a policy of humiliation is followed, let us take off the arms from those who are not worthy to bear them and let us take their position."

For our engraving we are indebted to L'Illustrazione Italiana.

INDIAN HEMP (CANNABIS INDICA SEU SATIVA).

By Dr. G. ARCHIE STOCKWELL, F.Z.S.

INDIAN, European and American hemp are one and the same, except as modified by locality, climate, soil and culture. The plant attains its highest medicinal virtues when grown in the tropics or sub-tropics, inasmuch as there it develops a large amount of resin (churrus), but in Canada and the United States the churrus is often practically nil.

The dried flowering tops of the female plant are the parts employed medicinally, and it is essential to medicinal virtue that the resin shall not be removed; these tops in their crude condition are known as "gunjah." The Arabian "hasheesh," Hindoo "bhang," and Mohammedan "majoon" are practically identical, being aromatic confections into which not only cannabis Indica, but the powdered seeds of stramonium, enter. Hasheesh is not, as has been stated, "the broken stalks of the hemp made up into fruits," nor "a mixture of opium, hemp and aromatics."

The chemistry of hemp is not well understood. The resin, or churrus, according to Egasse,* is the active principle, and has received the name of cannabin; but Helbing† gives this title to a supposed alkaloid of syrup-like consistency and brownish or greenish-black hue, scarcely at all soluble in water, but freely so in ether and alcohol. Jahns ‡ insists the only alkaloid is choline, and all other supposed principles are impure choline. Inasmuch as this same name obtains to a base found in plants and animals, formerly known as sinhaline and bitineurine, and described chemically as oxy-ethyl-trimethyl-ammonium, its applicability is questionable.

Cannabindon is another derivative of hemp, and appears in the form of a dark, cherry-red sirup.

The cannabine alkaloid of Merck is had in fine needles, but its relations to the entire drug are not yet fully determined; it is not even known that it is a true alkaloid. So, too, there is found in market another "alkaloid" bearing the same title, and which is a translucent, brown, sirupy liquid, with the hemp odor.

Cannabine tannate is a yellowish-brown powder with a tannin-like taste, not unpleasant smell, insoluble in pure water and ether, soluble in alcohol, and freely so in water made alkaline. It is said to be free from the two acrid and volatile oils peculiar to hemp, and which are generally held to be rapidly acting irritant poisons.

Cannabinine is a yellowish-brown, sirupy liquid, with an odor very similar to that of nicotine.

Cannabinon is a purified churrus of dark brown color, the consistency of treacle, and a most disagreeable taste. It also is insoluble in water.

In the Orient, churrus is smoked, and also manufactured into an intoxicating drink. A "butter" is also employed in the Hindostani peninsula, made by boiling together equal parts of ghee and cleansed hemp herb until the small amount of added water is all absorbed; while warm, it is pressed through loosely woven linen into a vessel filled with cold water; and this "butter," which is of a green hue, is frequently washed again either with pure water or rose-water. Sometimes a certain quantity of cleaned hemp herb is boiled in equal parts of water and of milk until the whole is reduced by evaporation to one-half its original bulk, then strained and curdled. The "butter" is afterward, in the usual manner, separated from the coagulation, and contains the effective (i. e., resinous) part of the herb. The "butter," too, is often flavored with spices and sugar, and by means of gum tragacanth converted into bonbons or lozenges. The latter were attempted to be introduced into medical practice in France by the late Germain Sée.

As a whole, cannabis is one of the most valuable of drugs, but is sadly handicapped by the uncertainty that attends all pharmacopœial preparations. Attempts to prepare by methods of assay have not been attended with any marked degree of success, owing to the fact that such have necessarily been based on the amount of the extractive. Too little is known regarding the so-called active principles to place any reliance on them as guides; consequently, the sole dependence of the prescriber is the character of the manufacturer, and the ability of the latter to judge of the crude drug employed. For such reasons cannabis requires to be employed with judgment and caution. It has been noted, too, that larger doses are required in temperate climes than in the tropics and sub-tropics, to produce a definite effect; but the real truth, doubtless, lies in the fact that the drug deteriorates with age and by transportation—perhaps loses some undetermined volatile constituent. The same precise preparation may prove active to-day, but given to the same individual under equally favorable conditions a few weeks later may prove practically inert. Honiberger observed that a resinous extract prepared for him in Calcutta was very much less energetic when he reached London.

Excellent results may be had from the use of a strong aqueous extract of the flowering tops of the female plant of the usual strength of fluid extracts. It possesses the anodyne and soporific action generally ascribed to the resin, although in a modified degree; has the characteristic odor of hemp and a beautiful deep amber color; is miscible in that it combines readily with other liquids. It offers all the benefits with none of the drawbacks of the tincture, and does not induce those extreme conditions of exhilaration bordering on intoxication that are sometimes met with. Finally, it does not interfere with the secretion of mucus from the bronchial glands—a circumstance which renders it superior to opium preparations.

Physiological Action.—The alkaloids appear to be hypnotic only, but all other preparations exhibit in a general way the activity of the crude drug. Minute doses are sedative to the spinal centers, and even when frequently repeated produce little other effect, except, perhaps, that some slight contraction of the pupils may be observed; but there is, nevertheless, inculcated a feeling of comfort and well-being, and not infrequently it seems to steady the action of the heart. Larger doses are stimulant; they first induce increased arterial action, followed by exhilaration, and as this latter passes off, drowsiness or stupor succeeds that may be almost cataleptic; but the awakening is free from malaise, nausea, headache or other untoward symptoms; the pupil of the eye is expanded. The preliminary effect is more powerful and lasting than that of opium, and the slumber it induces is commonly disturbed by dreams and spectral illusions. Also the sensory nerves are affected, as is evidenced by marked numbness and tingling, ushering in cutaneous anæsthesia and diminution of the muscular sense. Appetite is generally stimulated, and marked aphrodisia is not uncommon. Withal, the drug is a valuable anodyne and antispasmodic, its influence being manifested through the brain and cord. While in large doses it appears toxic, strange to say, in spite of the enormous quantities (relatively) that have been ingested on certain occasions, either accidentally or purposely, a case of death directly referable thereto has yet to be recorded. It is antagonized by caustic alkalies, vinegar and other acids, strychnine, electricity, antimonials, and blisters to nape of neck.

Cannabis Indica likewise exhibits a marked predilection for the genito-urinary apparatus, being strongly stimulant or sedative to the mucous tissue thereof, in accordance with the mode of exhibition and size of the dose; it is sometimes markedly diuretic, and appears to be excreted in part by the kidneys; but beyond this the eliminative process is unknown. Further, in atonic conditions, or inertia during labor, it stimulates uterine activity and induces physiological contractions, and at a time when ergot and kindred remedies prove useless.

Therapeutics.—Cannabis Indica is soporific or hypnotic, anodyne, antispasmodic, nervine stimulant, and, as already remarked, in some measure diuretic, aphrodisiac and oxytocic; consequently its scope of usefulness is a most extended one. Its most important effects, however, are to be found in the mental sphere, as, for instance, in senile insomnia, with wandering:

"An elderly person (perhaps with brain softening) is fidgety at night, goes to bed, gets up, thinks he has some appointment to keep, that he must dress and go out; daylight finds him quite rational again. Here nothing can compare in utility to a moderate dose of cannabis. In alcoholic subjects, however, it is uncertain and rarely useful. In melancholia it is sometimes serviceable in converting depression into exaltation. In the occasional night restlessness of paretics, and the 'temper disease' of Marshall Hall, it has proved eminently useful. In neuralgia, neuritis, migraine, it is by far the most useful of drugs, even when the disease has persisted for years. Many victims of diabolical 'sick headache' have for years kept their sufferings in abeyance by taking hemp at the threatened onset of the attack. It relieves the lightning pains of locomotor ataxia and also the multiform miseries of the gouty. Again, in chronic spasm, whether epileptic or choreic, it is of great service; also in the eclampsia of both children and adults. In brain tumors or other maladies, in the course of which epileptic seizures occur followed by coma, the coma being followed by delirium, first quiet, then violent, the delirium then passing into convulsions, and the whole gamut being repeated, Indian hemp will at once cut short such abnormal activities, even when all other treatment has failed; but in genuine epilepsy it is of little avail."*

In tetanus cannabis Indica has been found very efficacious at times, and in those cases wherein it is not curative, it seldom fails to afford some measure of relief. So, too, it is a favorite remedy in the Orient for epidemic cholera; patients in actual collapse have revived after taking a full dose; it seems to stimulate the nervous centers at a period when their influence is all but suspended. It is by no means a panacea as regards this malady, however, and is not so active as regards the dark as the white races, probably because the former are generally more or less habituated to its use.

In delirium tremens it often proves the most satisfactory of all remedies, its action resembling opium and wine, but much more certain. It readily dissipates the horrors, quiets nerve hyperæsthesia and conduces to cheerfulness. Great discrimination, however, is necessary in application.

In menorrhagia and uterine hæmorrhages, hemp may prove invaluable if judiciously employed; also in impending abortion. Mention has already been made of its power upon the gravid womb, inactive through inertia, and it may be added that it is equally efficacious as a preventive of post-partum hæmorrhage, or as a remedy after "flowing" has begun, but requires to be given in full doses, and sometimes to be reinforced by ergot. Here half drachm or even drachm doses of the fluid extract may be exhibited, since, strange to say, under these circumstances it never exhibits the ordinary physiological effects; there is neither excitement, intoxication nor tendency to somnolence, only a feeling of quiet, of well-being, and that the condition is one of perfect safety.

Cannabis is especially available for sensitive ovaries. Indeed, it seems sedative to all the pelvic viscera; and it is thus that it acts as an aphrodisiac, by allaying functional nerve irritation—not as has been supposed by stimulating erethism; and yet the latter effect may be had from large doses, but is apt to be most fleeting, or else assume the form of a priapism in man and nymphomania in woman, that is not gratified, much less satisfied, by sexual indulgence.

The value of hemp in allaying morbid irritability of the nervous system is such that it has been suggested as a means of relief from the distressing symptoms of vaso-motor coryza, popularly denominated "hay fever" or "hay asthma;" but there seems to have been no critical trial thereof; it is often efficacious, or at least palliative, in other asthmas, either when given by the mouth, or burned and its fumes inhaled, and there seems no reason why it should not be of benefit here; the idea is certainly commendable and rational, and worthy of experiment.

In violent palpitations of the heart the drug is often markedly remedial, especially when the non-utility of all other agents has been proved. The late Dr. Christison, of London, especially extolled it; he employed in a large number of instances with unequivocal effect, and by its aid succeeded in relieving a case of twenty-one years' standing.

In eczema and other cutaneous disorders accompanied with intolerable itching, cannabis gives relief when local treatment does not, but it must be employed in a way to secure its full and prompt effect. There are rarely any untoward manifestations, and it is best, perhaps, to first give in small doses and then gradually increase.

In certain diseases of the stomach and digestive apparatus the drug is often available, and is alway preferable to opium, in that it does not inhibit appetite, does not interfere with the secretions of either pancreas or liver, and neither constipates nor checks renal secretion. It is especially desirable in gastric neuroses and gastric dyspepsia. It not only allays painful sensation and improves appetite, but is of great service in promoting digestion and assimilation throughout the prima viæ; this is especially true in cases of hyperchlorhydria. In anachlorhydria it acts feebly; and it has no action on atony or dilatation. On the whole, it may be considered as a true gastric sedative, and it presents none of the disadvantages that accrue to opium, bismuth, potassium bromide, antipyrin, etc.

In the anorexia superinduced by exhaustive maladies—when there is repugnance and intolerance of food that is not relieved by acids, nux vomica and bitters—from five to ten minims of tincture cannabis, or one-quarter to one-half grain of the solid extract, given thrice daily before meals, often brings back the appetite in two or three days. In dyspeptic diarrhœa, also, and the first months of true tropical diarrhœas, it is often of great service. Tropical diarrhœa is primarily and essentially a disease of the liver, and mercury should first be administered. The cannabis acts by diminishing the irritability and excessive peristalsis of the intestines.

In rheumatism cannabis has been lauded for both its analgesic and curative effects, but it is questionable if it deserves the encomiums bestowed; but it may tend to alleviate pain, and is useful in so far as it contributes to increase appetite and promote mental cheerfulness.

It is also a capital sedative to the upper respiratory tract, and is a favorite factor in many cough mixtures. Fothergill, long ago, commended its use in phthisis pulmonalis, and declared it supplies a place that cannot be filled by any other drug.

Many eclectic physicians recommend it in Bright's disease where the urine is tinged with blood, but personal experience has not confirmed this. It is also upheld as an almost specific for urethral spasm, chordee, and the acute stage of blennorrhœa, etc. Nothing is more certain than that in the early stages of gonorrhœa, small doses, combined with gelsemium, subdue the disease much sooner and with greater comfort and safety than the old method of ruining the digestive powers with large doses of copaiba and turpentine. So, too, combined with gelsemium, it tends to subdue any inflammation of mucous tissue. In the spermatorrhea of highly nervous subjects it is especially valuable, and does excellent service if combined with Pareira brava in cases of irritable bladder.

It is somewhat surprising that cannabis is not more frequently employed in migraine, for it is by long odds the best remedy known. It is almost as valuable a drug in the treatment of other headaches, even the severe forms attending cerebral growths, or those dependent on uræmic poisoning. It is almost a specific for that continuous form which begins in the morning and lasts all day, the pain being generally dull and diffuse, but marked by occasional exacerbations. When the patient suffers constantly, or is liable to an attack of headache on the slightest provocation, a pill of one-third to one-half grain of the extract may be taken three times a day for many weeks at a time without the slightest fear of the production of any untoward effect. Should the patient not speedily obtain relief, care must be taken to ascertain that the extract employed is physiologically active.

After all that is said, it must be admitted few practitioners understand the real value of cannabis Indica, owing to the varied character of the preparations found in shops. The writer may say that constant use of the preparations manufactured by Squibb during more than a quarter of a century has proved their general uniformity and utility. The active principles, so called, offer no advantages, the resin churrus excepted, and are, if anything, more unreliable than the average solid and fluid extract. The "majoon" imported from India in foil wrappers is usually both uniform and palatable, but, unfortunately, difficult to procure.

The well known beauty of the China silks now produced in such large quantities in Zurich is said to be due to a peculiar process of preparing and printing the fabric there pursued. It has lately been fully disclosed in the Leipziger Färber Zeitung. Briefly, after the usual preliminary treatment the warp is stretched tightly on a table about twenty yards long and covered with a cloth, then printed by means of blocks, for which the colors are supplied from receptacles that slide in grooves along the entire length of the table. When the whole of the piece has been printed it is subjected to the action of superheated steam for about three-quarters of an hour, which fixes the color; this warp is now packed in a sack and worked backward in water by two men, to wash out the thickening used in the printing colors. The sack and its contents are at this stage wrung centrifugally, the warp taken out of the sack and hung up to dry, and finally brushed in order to close up the threads. The discharge printing of figured silk with a dark-dyed background has the unique advantage, as compared with the application of the background by means of printing, that the pattern is clearer and sharper, while the background itself is of a better color. The background is dyed with such coal-tar colors as can be discharged by zinc dust or tin salt, dyes being mixed with the discharge which are not affected thereby; thus, green, red, yellow and other parti-colored effects can be got on a dark ground and afterward steamed.

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* Bulletin Generale de Therapeutique, tome 118, 1890.

† Modern Materia Medica, 1892.

‡ Archives de Pharmacie, 1897.

* J. Russel Reynolds, The Lancet, London, March 2, 1890.

ENGINEERING NOTES.

A new rapid-fire gun of 6 mm. caliber is being made at the Colt's factory at Hartford, Connecticut. This gun is fitted with a land and a sea mount; it is capable of firing 200 shots per minute and has a range of 6,000 feet. At a test made at the Brooklyn Navy Yard, a bullet was sent through a ¾ inch steel plate, through 20 inches of wood backing, through a steam coil, and finally through another ⅛ inch steel plate. The metal in the barrel is one inch thick, to prevent overheating, and the cartridges are fed from a belt containing 1,000, stored in a steel box attached near the breech. This gun is now being turned out and forwarded to the navy yards in lots of fifty complete guns.

At the works of Messrs. Schneider & Company, at Creusot, France, various non-conducting coverings tried, such as silicate cotton, plastic compositions, etc., did not give good results, besides being costly, says The Engineering and Mining Journal. Finally, experiments were made with a mortar formed of granulated slag mixed with soot taken from the boilers or Cowper stoves. This compound is laid on easily with a trowel, in thicknesses varying from 1¼ inches to 2¼ inches, according to the size of the pipes. It is then wound round with felt, and a sheet steel covering is fitted over the felt for such pipes as are in the open, this casing being replaced by a cloth wrapping where the pipes are sheltered by buildings or shops. This inexpensive method is found to answer admirably, the temperature of the outside of the pipes thus protected being little higher than that of the surrounding air, so that condensation is reduced to a minimum.

"Rapid-fire or quick-firing guns are frequently referred to at this time, but few laymen really appreciate the meaning of the term as contrasted with the 'slow-fire' breech-loader," says The Engineering News. "The distinction is not one of size, for the rapid-fire system has extended from one-pounder projectiles to 4-inch, 5-inch and 6-inch guns, throwing 36, 70 and 100 pound shot or shell. The essential difference is in the method of loading. Instead of opening the breech and inserting the projectile and the powder separately, the latter in a bunting bag, ammunition for rapid-fire guns is now prepared as for small arms; the ball, powder and firing primer are united, the powder in a metallic case attached to the shot and the primer in the center of the base of this case. There are a number of types of rapid-fire guns, differing in the way this fixed ammunition is fed to the gun and fired. The 6-pounder (2·24-inch caliber) rapid-fire guns of the Hotchkiss, Driggs-Schroeder, Maxim-Nordenfelt and Sponsel types can discharge 100 shots in 4m. 26s., 4m. 35⅕s., 4m. 41s. and 4m. 56⅕s., respectively, or 20 to 25 shots per minute with accuracy of aim. Without attempt at accuracy of aim, the rate can be increased to 30 to 35 shots per minute. With 5-inch rapid-fire guns or 70-pounders, 36 shots have been fired in five minutes."

Besides the Austro-Hungarian naval programme of Baron von Spaun, other information of naval interest has just been published abroad. It is noted that the aggregate burden of the vessels forming the Russian fleet has increased during the last thirty years to the extent of 160,000 tons, that of the Italian fleet to 125,000 tons and of the German fleet to 250,000 tons. A German company building an armored cruiser named the "Varese," for the Italian government, has applied for permission to sell the ship to the Argentine Republic. Should the permission be granted, the construction company is prepared to deliver another cruiser of the same type to the Italian government within twelve months. A cruiser named the "Gazelle" has just been launched at Kiel for the German navy. Seven war vessels building in German yards will be delivered to the Chinese Department of Marine before the close of the year. They consist of three armored cruisers at the Vulcan Yard, at Stettin, and four torpedo boat destroyers being constructed in the Schichau Yard at Elbing. The cruisers "Hai Yung," "Hai Chen" and "Hai Shen" have twin screws; their length is 333 feet, their displacement 2,950 tons, and their engines have an indicated horse power of 7,500, which should give a speed of 19¼ knots an hour. Each cruiser has armor plates four inches thick, twenty-four guns, three torpedo dischargers, and two powerful search lights with a strength of 28,000 candles. Each crew will consist of 214 men. The four torpedo boat destroyers, "Hai Lung," "Hai Nju," "Hai Ching" and "Hai Hoha," are 210 feet in length and have engines of 6,500 horse power, which are guaranteed to produce a speed of thirty-two knots an hour.

The tramways of Paris are now operated by nine different systems of mechanical traction, as follows, in chronological order, says Engineering News: Rowan system of steam motors, 1889; Francq system of superheated water, 1889; cable traction, 1891; Serpollet system of instantaneous vaporization, 1892; accumulators with slow loading, 1893; compressed air, Mekarski system, 1895; electric traction by contact boxes, 1896; accumulators with quick loading, 1897; improved Serpollet system, 1897. The first regular system of mechanical traction, says the Revue Générale des Chemins de Fer, was installed in Paris in 1889 by the Compagnie Générale des Omnibus, on a special line to the exposition. The compressed air system of Mekarski was first tried, in 1876, on the Courbevoie L'Etoile line of the North Tramway Company, and has been working in Nantes since 1878. In 1895 the Compagnie Générale applied it, first on the line from the Louvre to St. Cloud, Sevres and Versailles, and then to Vincennes. The electric system used is that of Claret Vuilleumier, and is operated on a line from the Place de la Republique to Romainville. The latest accumulator system is used on three lines starting from the Madeleine; and the perfected Serpollet steam type is employed on a line running from St. Ouen to the Bastille. On these lines, which have an aggregate length of 52 miles, 211 vehicles are used; the Paris tramway lines, operated by horses, have a total length of 129 miles and use 478 conveyances, not including those in reserve. It is estimated that an expenditure of about $18,000,000 would be required to transform all the lines to some system of mechanical traction; and the contention is made by those interested that this improvement would be sufficiently effective and vastly more economical than the metropolitan rapid transit plan proposed, which would cost about $60,000,000 when completed.

MISCELLANEOUS NOTES.

Herr Appunn, of Hanau, has invented a bell of a new shape, which is said to have a very deep tone, and to be as powerful as considerably heavier bells of the form at present in vogue. The shape is peculiar, being hemispherical, while the metal is uniform in thickness except near the "sound bow" (or the thickened tip which the clapper strikes). From the edge to some little distance above the sound bow the metal is very thick, and then alters suddenly to the uniform thickness which it has for the rest of the bell.—Invention.

The number of teachers employed by the Harvard University is 404, ten more than last year, and the number of students in attendance in all departments is 3,866, an increase of 192. Harvard College numbers 1,819 students, an increase of 65; the Lawrence Scientific School 410, an increase of 42. In the scientific school six courses in mining and metallurgy are offered. The development of manual training in this school is noticeable; besides courses in shopwork, in metals and in wood, there are courses now in blacksmithing, in casting and foundry practice, in carpentry and in modeling in clay, while four kinds of shopwork are among the proposed requirements for admission to the school.

The German government has just published statistics giving the state of export trade for the first quarter of 1898. It is shown that the exportations to the United States from most of the German trading centers have declined as compared with those during a similar period of 1897. The most striking decrease is that of the consular district of Hamburg, which is $1,511,070, as against $3,490,990 in 1897; Annaberg, $154,590, against $190,661; Frankfort-on-Main, $7,998,761, against $9,485,521; Eibenstock, $191,343, against $213,398; Breslau, $293,359, against $375,360; Plauen, $567,161, against $870,081; Berlin, $1,137,027, against $1,249,531. The district of Gera, in which woolen goods are the chief staple, shows an increase—1,455,628 marks, against 1,350,974 marks in 1897.

The Engineering and Mining Journal quotes extracts from an advance proof issued by the Home Office containing mining statistics for 1897 in Great Britain. This shows that Great Britain produced 202,119,196 long tons of coal, the largest ever produced for that country, and leading the world. The increase over the previous year was 6,767,245 long tons. Production of fire clay, 2,682,472 tons; increase, 156,428 tons. Iron ore production, 7,793,168 tons; decrease, 53,418 tons. Oil shale, 2,223,757 tons; decrease, 195,780 tons. While the production of iron ore shows a decrease, the make of pig iron in 1897 was larger than in 1896, thus showing that British ironmasters are depending every year more on imported ores. Total number of persons employed in this class of mines in 1897 in Great Britain was 659,213, an increase of 2,529 persons.

The resources of the island of Cuba have for a while been a matter of minor consideration, owing to the political events that have overshadowed the destiny and development of the Gem of the Antilles, says The Age of Steel. Previous to this industrial eclipse foreign capital flowed in to aid in the exploitation of its resources, mineral and otherwise. Considerable sums of money were invested and much of spirited and aggressive enterprise shown in this direction. For some fourteen years or more Bessemer hematite has been mined in the southeastern districts of the island. The United States alone has imported some 3,000,000 tons of this ore. About a year ago some of this Cuban ore was shipped to Europe, where its special qualities were promptly appreciated. The comparative shortage of ore of this kind in British and European hands led to a steady and growing demand, which is likely to increase rather than slacken when peace is permanently restored and industries are not terrorized by irresponsible guerrillas or any other type of armed forces and the channels of trade are not obstructed by internal disruptions and implacable belligerency. The methods of mining, as so far adopted, are not costly, labor is not highly paid and transportation to the seaboard is on the same line of economy. It can be readily seen that with such advantages the demand for Cuban iron ore is not likely to decline. The ore has been thoroughly tested, its special qualities determined, and the fact that 50,000 tons were shipped to Europe and Great Britain during the past season is in cumulative evidence of what may be done when the political horizon is cleared and the last impediment to open trade is removed.

The latest statistics presented by the American Iron and Steel Association give the production of iron and steel wire rods in the United States during 1897. Last year recorded the largest production in the history of the American wire rod industry, as the total was 970,736 gross tons, against 623,986 tons in 1896 and 791,130 tons in 1895, showing an increase of 346,750 tons, or over 55 per cent. over 1896 and 179,606 tons over 1895. The following table, taken from The Bulletin, shows our production of wire rods by States during the past four years:

States.	Gross tons— 1894.	1895.	1896.	1897.
New England, New York, New Jersey	109,793	113,803	79,733	94,471
Pennsylvania	246,101	278,406	233,352	351,676
Ohio	173,272	210,058	146,329	265,317
Indiana, Illinois	144,236	188,863	164,572	259,272
Totals	673,402	791,130	623,986	970,736
Iron	5,772	2,840	2,473	2,019
Steel	667,630	788,290	621,513	968,717

It will be seen by the foregoing that Pennsylvania made the largest quantity of wire rods in 1897, with Ohio second in her production, Illinois third and Massachusetts fourth. Three other States, Connecticut, New Jersey and Indiana, also rolled rods in 1897. Another fact shown by the table is the small figure which iron now cuts in the production of wire rods. Out of a total of 673,402 tons of rods made in 1894, 5,772 tons were iron. Each year since has seen less iron used in this line, and last year there were 968,717 tons of steel rods turned out, while only 2,019 tons of iron rods were manufactured.

SELECTED FORMULÆ.

Preparation of Lactic Acid.—Prof. Kassner points out that the use of zinc oxide for neutralizing lactic acid produced by fermentation, so as to obtain zinc lactate without subsequent decomposition of the calcium lactate produced when chalk is used, does not answer so well as the older method, and he attributes the difference to the formation of a soluble zinc salt which destroys the micro-organism that produces lactic acid. He therefore recommends that chalk should be used instead of zinc oxide, and that in the subsequent treatment of the calcium lactate solution with zinc chloride an excess of the latter should be avoided, as it prevents the crystallization of zinc lactate.—Apotheker Zeitung, 1897, p. 325.

Remedy for Chrysanthemum Rust.—R. W. Hodder states that this new disease, which has only appeared within the last twelve months, may be eradicated by the following treatment: Half a pound of whale oil soap is boiled in a gallon of water; to the boiling solution a gallon of petroleum is added, and 2 ounces of ammonium carbonate; the mixture is then heated to boiling with constant stirring until thoroughly emulsified. One part of this emulsion with 15 parts of water are used to syringe the plants, both the upper and under sides of the leaves being well sprayed with the solution. When treated in this way, the spots soon dry up. In addition to killing the rust, it is a good insecticide, and will clear off any insects with which the plants may be infested. Where the fungus makes its appearance in a collection of plants, the whole should be treated by this method, or the rust will constantly appear.—Garden, liii., 247.

Caoutchouc and India Rubber Cements.—The Bayerische Industrie Gewerbeblatt gives the following useful formulæ for this class of cements, which are daily coming into more universal demand, with the spread of the bicycle and other rubber-tired vehicles, rubber garments and the varied applications in domestic affairs to which such cements are suited.

CEMENT FOR LEATHER AND GUTTA-PERCHA.

Melt together 100 parts of gutta-percha, 100 parts of asphaltum (or coal tar pitch) and 15 parts of oil of turpentine. Apply hot.

CEMENT FOR LEATHER TO LEATHER.

This is admirably designed for patching shoes ("invisible patches"), attaching soles that have become "started," etc., as it is elastic, and thus, to a certain extent, permits of motion in the joint without fracture of the line of union. Its formula is as follows: Dissolve 10 parts of gutta-percha in 100 parts of benzol, pour the solution into 100 parts of linseed oil varnish, and stir until a homogeneous mixture is obtained. To make a firm and nicely appearing job, the patch should be chamfered down at the edges with a keen knife, and the shoe leather trimmed away around the break, so as to present a clean, fresh surface to the cement. A little practice will soon make one expert at this work. To give a boot that has been thus treated a brilliant polish, the author recommends the following:

LEATHER POLISH.

Casein, quantum sufficit.
Borax, q. s.
Boiling water, q. s.

Dissolve the borax in boiling water, and to the solution add as much freshly precipitated casein as it will dissolve, maintaining the heat in the meantime. [Nigrosin, or bone-black, or both, may be added, if desirable. In case ordinary bone-black be used, the addition of a little indigo or Prussian blue intensifies the blackness. If bone-black purified, as has been frequently described in The National Druggist, be used, this addition will be unnecessary.—Editor N. D.]

RUBBER, VULCANIZED MATERIAL, ETC., TO METAL.

Add 1 part of coarsely powdered shellac to 10 parts of strongest liquor ammoniæ, and set aside in a well stoppered vessel, until complete solution, which occurs in from three to four weeks, according to the temperature at which the vessel is kept. This is used cold, a layer being applied to each surface, and the parts left until a portion of the solvent has evaporated, then join and apply a weight or compression. The joint thus made is water and gas proof. It may be used for joining vulcanized rubber, hard or soft, to almost any and every other material—glass, metals, etc.

BICYCLE CEMENT.

For wheels tired with rubber tubing the foregoing cement answers every purpose. Leather tiring is, however, best repaired with the following:

Carbon disulphide	10 parts.
Oil of turpentine	1 "
Gutta-percha, cut in small pieces, q. s.	

Mix the turpentine and carbon disulphide and add sufficient gutta-percha, under frequent agitations, or rubbing up, until a thick paste is obtained. To make a good joint all fatty and greasy matter must be got rid of, and the surface of the leather freshened, either by the use of a rasp, emery paper or knife, before applying the paste.

CAOUTCHOUC CEMENT.

Caoutchouc, cut in fine pieces	100 parts.
Resin	15 "
Shellac	10 "
Carbon disulphide, q. s. to dissolve.	

Mix and make a solution, or:

Caoutchouc	1 part.
Mastic	7 "
Chloroform	50 "

Mix and let stand until dissolved (which will require several weeks).

CEMENT FOR MENDING GUM SHOES.

Caoutchouc	62 parts.
Chloroform	250 "

Mix and dissolve. Then take—

Caoutchouc	60 parts.
Resin	24 "
Oil of turpentine	250 "

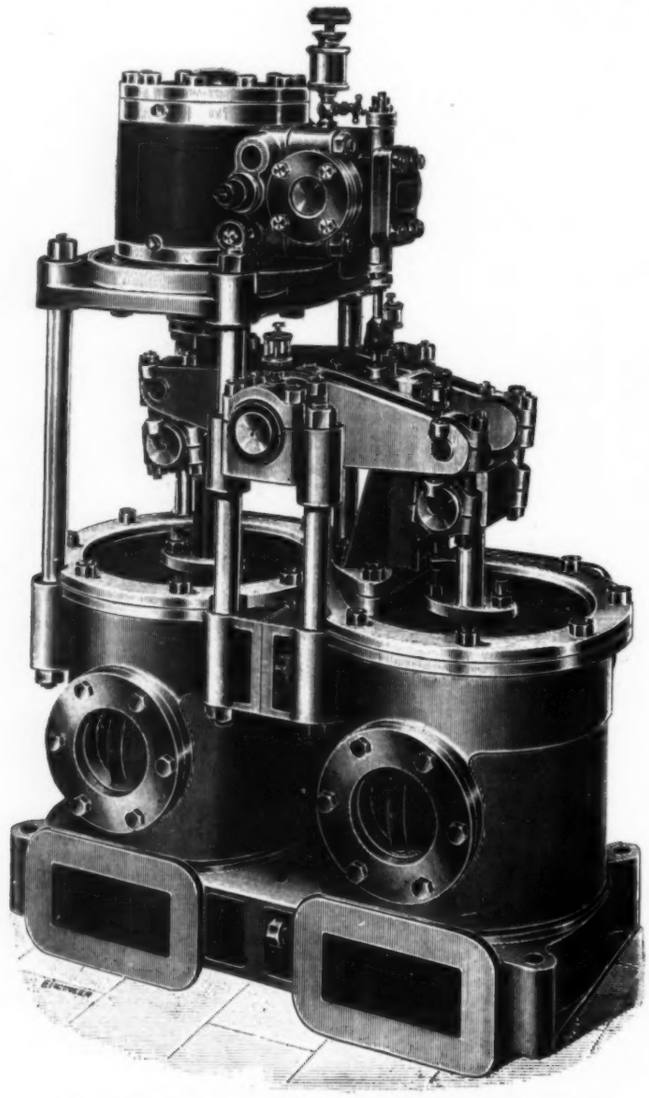
Mix and dissolve. When complete solution has taken place in both cases, mix the two solutions, and agitate until homogeneous. Use cold, and apply a portion of the cement to each surface to be joined.—National Druggist.

ENGINES OF THE FERRY STEAMER "CHEBUCTO."

THE double screw ferry steamer "Chebucto," recently built by Messrs. John Shearer and Sons, Kelvinhaugh, Glasgow, and engined by Messrs. McKie and Baxter, of Copland Works, Govan, to the order of the Ferries Commission of Dartmouth, Nova Scotia, has a screw propeller and a rudder at each end, both propellers being actuated in propelling the vessel, while the rudder at the "ahead" end is locked firmly in the fore-and-aft position by simple gear controlled from each pilot house. The main driving engines consist of two pairs of compound surface condensing engines built upon one bed plate, with low pressure receivers separated only by a division plate. The cylinders are bolted together in line—the two low pressure cylinders, 24 inches diameter, inside, and the two high pressure cylinders, 12 inches diameter, outside. The stroke is 18 inches, and when both engines are working, as is the case when the vessel is on her station, she is thus propelled by a double four-crank engine actuating a screw aft and a similar screw forward. Each of the propellers is 6 feet 3 inches diameter by 8 feet 3 inches pitch, having four blades of 15 square feet of surface and with both front and back faces of blades of the same shape.

The engines are reversed by direct acting steam gear upon an entirely new principle, the invention of Mr. Baxter, of the engineering firm, in conjunction with Mr. D. B. Donald, of Falmouth. Steam is supplied at a pressure of 135 pounds from two boilers of the Admiralty pattern, each having two furnaces of Fox's corrugated type. The diameter of boilers is 7 feet 6 inches and the length 18 feet, the furnaces being 36 inches diameter and 7 feet 9 inches long. The total grate surface is 1,700 square feet and the boiler tubes are unusually large in diameter.

The pumps and auxiliary engines of various kinds, of which there are over a dozen on board, are all dissociated structurally from the main engines. There is an installation comprising five pumps by the Blake and Knowles Steam Pump Works Company, including a duplex independent air pump, having a 6-inch cylinder driving direct without rotary motion a pair of air cylinders, 12 inches diameter by 8 inch stroke. We understand the air pump, which we illustrate, is the first of its kind that has ever been fitted to a vessel in this country, although they are already much in favor in the States. The pump actually fitted was intended for a vessel of the American navy, but was given to Messrs. McKie and Baxter, in order that they might comply with the delivery requirements. There is also a special form of feed pump, 5¼ inches by 3½ inches by 6 inches; a donkey pump, 4½ inches by 2¾ inches by 4 inches; a boiler circulating pump and a sanitary pump, each 3 inches by 2 inches by 3 inches. All these pumps are of the Blake and Knowles special horizontal duplex type. Hancock inspirators are fitted for feeding the boilers and Hancock ejectors for clearing the bilges. The air pump discharges into a tank from which the feed pump draws through a filter, the speed of the pump being automatically controlled by a float. The exhaust steam from all the auxiliary engines, including electric light engine and steam windlass—for the Atlantic voyage only—is carried to the condenser, which has a cooling surface of 500 square feet, and the feed water passes through a heater on its way to the boilers. The centrifugal circulating pump, which has a 5½ inch suction and discharge and is 20 inches in diameter, made by McKie and Baxter themselves, is one of their "Challenge" patterns, and is fitted with a special balanced valve, the invention of Mr. Baxter. The electric generating machinery consists of a 4 kilowatts dynamo, with Sayers' winding, fitted on same bed plate with and driven by a Paul engine, having a 5 inch cylinder by 5 inch stroke. The installation, equal to sixty lights of 16 candle power, is on Mavor and Coulson's "concentric" system, and includes four side signal lights, two tower lights and four three-light pendants in each saloon.



S. S. "CHEBUCTO"—DUPLEX INDEPENDENT AIR PUMP.

The "Chebucto" went through her speed trials on the Firth of Clyde on the 12th of August, with results which were entirely satisfactory, and left the Clyde for her destination on the 9th of September. The working of Messrs. Baxter and Donald's patent starting and reversing engine was an admirable feature of the trials. In this gear the necessity for the hydraulic cylinder, which has been so constantly employed till now in gears of this kind, is entirely dispensed with. The engines can be reversed at almost any speed, the promptness of the action being remarkable. From the construction of the gear it is impossible to do damage or to carry away anything.—Engineer.

H. M. S. "HERON."

LIGHT DRAUGHT RIVER GUNBOAT, BY YARROW & COMPANY, LONDON.

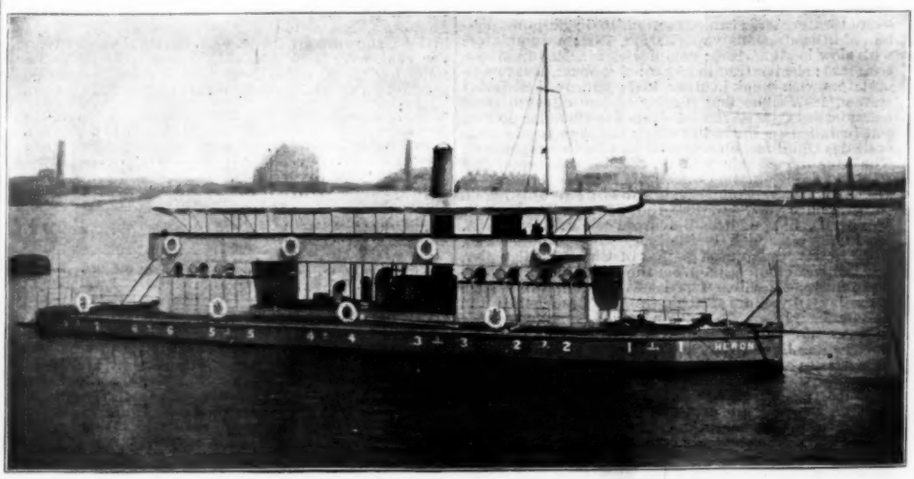
THIS is the first of six vessels ordered by the British Admiralty from Messrs. Yarrow & Company, in the latter end of 1896. They are 100 feet in length by 20 feet beam, and constructed in eight floatable sections, like many stern-wheel steamers which this firm has constructed for the British and other governments. The hull is cut transversely into eight parts of comparatively small size, bulkheads being provided at the ends of each such part, which can be lowered from the deck of the transporting steamer into the water alongside and then bolted together, thus forming an entire hull of the gunboat. The whole of the boat proper is constructed of galvanized steel, which galvanizing adds greatly to the life of the vessel. The draught of water in a fully equipped and laden condition is only 2 feet, which makes these vessels most useful for ascending shallow rivers, as their speed is fairly good, viz., about 10½ miles per hour.

On the main deck of the vessel there are cabins for officers and warrant officers, and on these is a second or battery deck, on which are quick-firing guns and rifle caliber automatic guns. These, as well as the cabins, are protected from rifle bullets by bulwarks and shields of very hard and strong steel, which is perfectly rifle-shotproof. The steering wheel is on the forward part of the upper deck inside a bulletproof conning tower. The vessel can be steered either by steam steering gear or by hand, and there are three rudders, to secure great maneuvering power, which, of course, is necessary in navigating tortuous rivers. The officers have their quarters in the forward end of the vessel on the main deck, and the crew sleep under canvas on the battery deck. The holds under the main deck contain the magazines and provisions.

The propelling machinery consists of twin screws working in tunnels in the after part of the hull, actuated by two sets of triple expansion surface condensing engines. The boiler is of the Yarrow water tube type, arranged to work under forced draught in a closed stokehold, for which purpose there is a fan and engine on the plan of a torpedo boat. The boiler is designed for the use of wood fuel. There is a centrifugal circulating pump and engine, also an evaporator for making fresh water for drinking purposes as well as for the supply of the boilers.

The speed, fully armed and provisioned, is, as mentioned, 10½ miles per hour.

The "Heron" arrangement of propellers requires a few words of explanation: As the propellers must not project below the bottom of the boat, the draught of water (being limited to 2 feet) would not admit of a larger propeller being used than about 2 feet diameter, with the usual arrangement of the stern. In order, however, to propel so large and beamy a vessel at 10 to 11 miles per hour it requires two screws of at least 3 feet 5 inches diameter, which would be uncovered with water for a large part of their diameter unless the following device were adopted: The propellers work within two channels raised up in the bottom of the boat, the upper part of these being well above water. As soon as the propellers begin to revolve, they rapidly expel the air from the upper part of the tunnels or inverted diving bells, and then they work in solid water, enabling them to drive the vessel efficiently, although not with equal efficiency to what it would be if the draught had admitted of the ordinary screw. On the highest part of each tunnel there is an airtight door, which is, conse-



H. M. S. "HERON."

quently, always above the surrounding water, and through which access is obtained to the propellers for renewals or clearing away weeds. A propeller can be removed and replaced by another within ten minutes.

Projecting from the stem of the boat is a long hollow steel pole, from which a steel lever hangs down to any desired depth below water. Should the vessel get into shallow water and be in danger of running aground, the lever touches first, and by means of a cord rings an alarm bell in the pilot house, thus giving timely warning to the pilot to stop the engines. This draught indicator is usually set to touch the ground at a draught of 12 or 18 inches greater than the draught of the steamer.

Another provision is made by means of two steel poles with mushroom heads and two special winches for pushing off or lifting the fore end of the boat from a bank, should she, notwithstanding the first named warning device, get aground.

We have already mentioned that the crew are berthed on the battery deck under canvas, well above the river level, which is important in hot and unhealthy locations.

The canvas roof is supported by a strong, wooden framework, from which the hammocks are slung. Every convenience is provided in the shape of lockers, mess tables, small arm racks, etc., and the upper deck is thus converted into a cool, roomy mess room.

Two of these gunboats are on the Niger, having been put together at the mouth of that river, and in actual work this system of propulsion is giving the best possible results, the propellers being completely incased and well protected from damage.

THE DUSSAUD TÉLÉOSCOPE.

IN a communication that I made on the 17th of November, 1880, to the Society of Civil Engineers, of France, upon the photophone of Graham Bell, the celebrated inventor of the telephone, I pointed out the fact that the singular property possessed by selenium of assuming electric conductivity, variable according to the intensity of the light, had aroused the efforts of inventors, who were occupying themselves with the question of vision at a distance through the intermedium of a simple electric conducting wire.

Since then I have thought it would be well to encourage new researches into this problem, in order, if possible, to solve it through the execution of one of the apparatus proposed for attaining the object desired.

This is why I called the attention of the High Commission of the Exposition of 1900 to this question and to the opportunity that would exist of showing visitors this new marvel anticipated by science. This desire, now taken into consideration, is to be realized. Prof. d'Arsonval, of the College of France, on the 18th of April last, presented to the Academy of Sciences the conclusive results obtained by M. Dussaud upon vision at a distance by means of an apparatus that has been named the "Dussaud téléoscope." I am happy to be able to make the apparatus known in this place; but, before doing so, I wish to recall the few experiments made in this direction.

It was M. Senlecque, a Frenchman, who, in 1878, stated with precision the terms of the problem of vision at a distance; but, like M. de Paiva, who was occupying himself with it at the same epoch, he was unable to realize his project.

In 1880, M. Carrey, and afterward M. Bidwell, putting into execution an idea conceived by M. Sawyer, produced, not vision at a distance, but an inscription of drawings in a manner analogous to that effected by the autographic telegraph. Shortly afterward, Messrs. Ayrton and Perry made a series of experiments in the reproduction of black and white bands; but things remained in the state of laboratory experiment, having no practical application. Finally, M. Lazare Weiller proposed an ingenious solution of this difficult problem, but his project had no outcome.

M. Dussaud, the inventor of the microphonograph, an amplifier of sounds which is now rendering constant services to the deaf and to deaf mutes, has just made a lengthy experimental study of vision at a distance, and has devised an apparatus of which the operation may be easily understood from an inspection of Figs. 1 and 2, which exhibit the principles of the experiments in their essential elements.

To the left (Fig. 1) stands the person whom it is desired to see at a distance, and whose movements it is desired to follow. At B is a camera which rights the images and the back of which is formed of the following parts: (1) of a movable shutter, C, containing apertures arranged in a spiral; and (2) of a peculiar system of selenite plates. At E there is a battery, of which the current passes through the selenite plates and the coarse wire of an induction coil, F.

The person in motion forms a movable image at the back of the camera, as in a photographic apparatus, and the different, more or less luminous parts of this image strike in succession the selenite plates, D, in measure as the movable shutter, C, presents its apertures. This shutter is actuated by a clockwork mechanism, G, analogous to that of the Hughes telegraph.

Selenium, as we know, opposes itself more or less to the passage of electricity, according to the quantity of light that it receives. Therefore, according as the shutter, C, uncovers the more or less luminous parts of the image, currents of varying intensity will pass through the coarse wire of the induction coil, F. These, according to a well known law, cause proportionate currents in the fine wire of the coil. This fine wire ends on the one hand in the earth and on the other goes to the receiving station (Fig. 2), where the currents of varying intensity that traverse it cause the vibration of the disk of a sort of very sensitive telephone, H. This disk acts upon an opaque plate, K, provided with transparent lines and displaces it more or less in front of an identical but stationary plate, L. These plates are protected against external disturbance by glass. The result is that a pencil of parallel light, M, produced by a lamp, N, with crossed carbons, and obliged to pass through the two opaque plates, is more or less diminished throughout its whole extent, according to the currents that pass through the fine wire. But, thanks to a shutter, O, identical and synchronous with C, this variation in intensity is projected upon the screen by an optical system, P, only at the place corresponding to the part of the image which, at the transmitting station, has the same intensity. Since the two shutters, C and O, make one complete revolution in one-tenth of a second, all the parts of the image act successively upon the selenium during this time, at the transmitting station, and give different intensities to the current at the receiving station, and thus project luminous intensities that correspond to their respective intensity.

Any observer, then, at the receiving station sees upon the screen the person placed at the transmitting station, by virtue of the persistence of luminous impressions, which is one-tenth of a second, and by the fact that it suffices to have all small surfaces more or less light, in order to reproduce a portrait.

In conclusion, we express the hope that M. Dussaud, in improving his apparatus, may bring it to the point desired for the Exposition of 1900, of which it will constitute one of the finest and most serious attractions. After the téléoscope, like the telephone, has entered practical life, we shall have realized that wonderful double effect of being able not only to hear one another, but also to see one another at considerable distances; and thus will be suppressed the remoteness of men!—M. Armengaud, in La Nature.

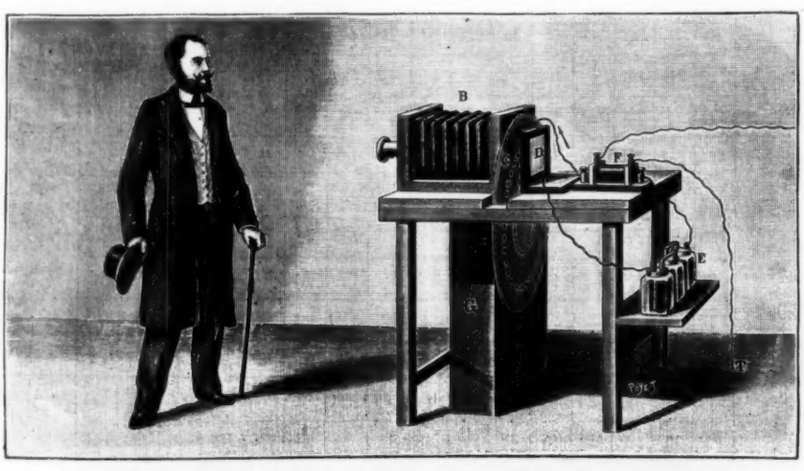


FIG. 1.—THE DUSSAUD TÉLÉOSCOPE—TRANSMITTING APPARATUS.

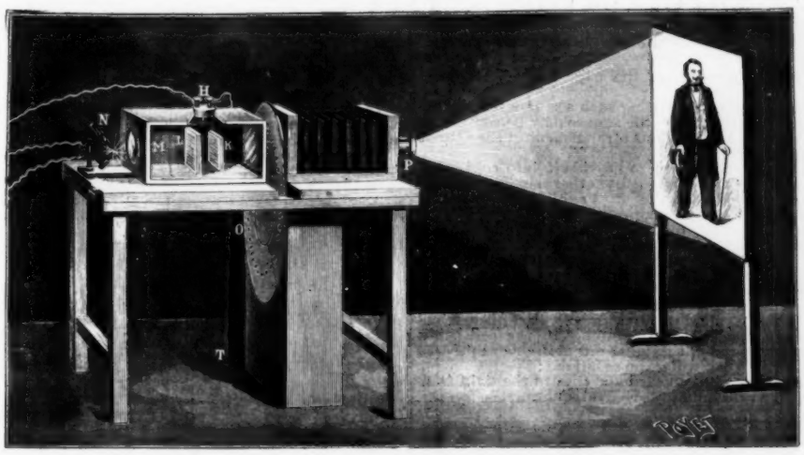


FIG. 2.—THE DUSSAUD TÉLÉOSCOPE—RECEIVING APPARATUS.

It will be seventy years on July 4, 1898, since the corner stone of the present Baltimore and Ohio Railroad was laid in Baltimore by Charles Carroll, of Carrollton, who, as is well known, was one of the signers of the Declaration of Independence. This fact was brought to mind recently by the removal from the B. and O. treasurer's vault to the Masonic Temple in Baltimore of the masonic emblems and tools which were used by Gen. Carroll during the ceremonies of laying the corner stone. They consist of badges, a trowel, a spade, and a stone cutter's hammer, and also the apron worn by Thomas Young Nichol, a working stone mason, who performed the actual labor of setting the corner stone in its place. There was a very large procession of mechanics, civilians, military, etc., on that day, and one of the relics still preserved is a tin cup made by the tin plate workers who were in the procession on a large float.

MAGIC SQUARES.

IN Albert Dürer's picture of "Melancholy," which was painted about the year 1500, one of the figures is represented as wearing a charm or amulet, the design of which is a peculiar arrangement of figures in the form of a square. These "magic squares," as they were called, were held in high repute during the middle ages, and, when engraved upon plates of silver and worn upon the person as a charm, they were believed to render the wearer proof against attacks of the plague. There is no doubt that they were fully as efficacious as is the stolen potato carried in the pocket of the present day against attacks of rheumatism. In addition to their value in medicine, the peculiar combinations of numbers to which they gave rise attracted the attention of learned mathematicians, who were more interested in the merely curious things that can be done with numbers than are their followers of the present day.

Moschopulus, who died about 1470, was the first writer on the mathematical theory of such squares, and his work still exists in manuscript in the National Library at Paris. Euler, who lived during the first half of the eighteenth century, was interested in them, and articles discussing them have appeared in journals and reports even within only a few years.

A magic square is a square made up of numbers so arranged in parallel and equal rows that the sum of the numbers in each row, taken perpendicularly, horizontally or diagonally, is the same. Its simplest form is that which consists of the first nine figures arranged as in Fig. 1. In whatever direction a row of three figures be added, the constant sum 15 is obtained.

8	1	6
3	5	7
4	9	2

FIG. 1.

It is possible to write a magic square of any size, if the number of figures in a row be an odd number, or if it be a multiple of four. There is no rule for writing a magic square in which the number of figures in a row is an even number, and not a multiple of four. Such a square can only be made empirically.

One method of making a magic square in which the number of figures in each row is odd is as follows:

Write the figures first in regular order as in Fig. 2, and draw the diagonal lines as shown there. This forms a square containing the proper number of cells, some of which are filled with figures, while others are vacant. To fill the vacant cells, move the figures which are outside the square along the diagonal rows to which they stand

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

FIG. 2.

opposite, to the most distant vacant cells in that row. Thus, 6 is to be moved downward toward the right to the vacant square between 23 and 19, 1 to the cell between 18 and 14, 2 to the cell between 19 and 15. Then move 4 downward toward the left to the cell between 11 and 17, 5 to the cell between 12 and 18, and so on until all the outside figures have been moved in. As a result we have Fig. 3, the only difference being that

3	16	9	22	15
20	8	21	14	2
7	25	13	1	19
24	12	5	18	6
11	4	17	10	23

FIG. 3.

it is placed erect upon the page instead of diagonally.

Another method of writing such a square has the advantage that, by its use, the square may be written at once, without any previous arrangement of the figures. It is as follows:

Draw the large square and divide it into cells. Imagine it to be surrounded by other similar squares, similarly divided as in Fig. 4. Begin by placing 1 in the middle cell of the upper row; then, following the row of cells diagonally upward and toward the right, continue by writing the numbers in order. When the numbers run out of the central square at the top or at the right side into one of the outside squares, place the next number in the corresponding cell of the central square, and proceed as before. When a cell which has already been filled is encountered, write the next number in the cell below that in which the last number was written and proceed again. The work will go on as follows:

Going diagonally upward and toward the right from 1 (Fig. 4), 2 runs out of the central square at the top and

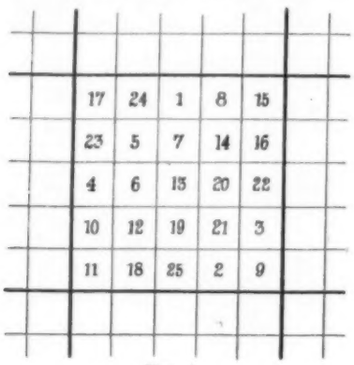


FIG. 4.

finds its place in the lower row of the square above, and in the second cell from the right corner. Write it in the corresponding cell of the central square. It is followed regularly by 3; 4 runs out of the central square at the right and finds its place in the middle cell of the left hand column. Place it in the corresponding cell of the central square and proceed. When 6 is reached, the cell in which it should fall is already occupied by 1. Write the 6 immediately under the 5, and proceed as before until all the cells are filled.

It will be noticed that the arrangement of the numbers in Fig. 4 is different from that in Fig. 3. The arrangement in Fig. 3 may also be written down at once by following a rule similar to that given for Fig. 4, the difference being that the work begins by writing 1 in the cell at the right of the central cell, and proceeding diagonally upward toward the right as before. When a cell which has already been filled is encountered, move two cells toward the right and begin again.

An examination of the arrangement of the numbers in Figs. 3 and 4 will reveal some of the peculiar properties of magic squares. If a straight line be drawn in any direction through the central cell, the sum of any two numbers on that line which are equally distant from the central cell is always equal to the same number. In any magic square formed in this manner the sum of two such numbers is equal to the square of the number of cells in a row plus 1. This affords a means for ascertaining what the sum of the numbers in a row of a square of any size will be without actually writing the square, for the number of such pairs in a diagonal row, for example, will be just half the number of single figures in the row. The sum of the figures in a row is, therefore, equal to the square of the number of figures in a row plus 1 multiplied by one-half the

24	3	18
9	15	21
12	27	6

FIG. 5.

number of figures in a row. If we represent the number of figures in a row by x, the following formula will give the sum of the figures in a row: $\frac{x}{2}(x^2+1)$. Applied to Figs. 3 and 4, this gives 26 multiplied by $2\frac{1}{2}$, or 65.

Since numbers taken in regular order form an arithmetical progression, it naturally follows that any series of numbers which form an arithmetical progression may be formed into a magic square. In Fig. 5 we have such a square made up of the first nine multiples of 3. Here another factor enters into the formula given above, and that factor is the common difference, 3. The sum of any row in Fig. 5 is 45, instead of 15, as in Fig. 1.

If the numbers which form a geometrical progression be written in a magic square, the continued product of the numbers in a row will be constant. Fig. 6 is made

2^8	2^1	2^6
2^3	2^5	2^7
2^4	2^9	2^2

FIG. 6.

up of the first nine powers of 2. It will be noticed that the exponents are arranged in the same order as are the numbers in Fig. 1. Addition of these exponents, i. e., the continued multiplication of the numbers, gives as the constant product the fifteenth power of 2. In any similar square the formula given above gives the index of the power represented by the product.

The construction of a magic square in which the number of figures in a row is a multipie of 4 depends upon that of a magic square of sixteen cells. To construct such a square, write the numbers from 1 to 16 in regular order, as in Fig 7. The application of the

1	5	9	13
2	6	10	14
3	7	11	15
4	8	12	16

FIG. 7.

formula shows that the sum of the numbers in any row should be 34. This is true of the diagonal rows in Fig. 7, but not of those which are perpendicular or horizontal. An examination of these rows, however, shows that the excess above 34 in the last column is equal to the deficiency in the first. The same is true of the third and second columns, and of the fourth and first and the third and second rows. The sum of any two numbers which are on opposite sides of and equally distant from the center is already equal to 16+1, as it should be. Hence, if we transpose 2 and 15, 3 and 14, 5 and 12, and 9 and 8, allowing the diagonal rows to

1	12	8	13
15	6	10	3
14	7	11	2
4	9	5	16

FIG. 8.

remain unaltered, we have the square shown in Fig. 8, in which the sum of the numbers in each row is 34.

In order to make use of this square in the construction of larger squares, it is necessary that the sum of the numbers in any small square of four cells should also be equal to the sum of the numbers in any row. This is true only of the four central numbers, and of the four in each corner. It is evident, however, that entire columns or entire rows may be transposed without destroying the symmetry of the figure. If we place the third column at the left side, and then transpose the first and second rows, we obtain the arrangement shown in Fig. 9, in which the sum of the numbers in four adjacent cells, wherever taken, is the same.

Larger squares, in which the number of figures in a row is a multiple of 4, are made up of squares of sixteen numbers each, and the arrangement shown in Fig. 9 is used to assist in their construction. One large

10	15	6	3
8	1	12	13
11	14	7	2
5	4	9	16

FIG. 9.

square, which was at one time considered as of great importance, and was called the magic square of magic squares, consists of the first 256 numbers. It consequently contains 16 small squares of 16 numbers each. It is constructed as follows:

Arrange the numbers from 1 to 256 in pairs, thus:

1 2 3 4 5 6 7
256 255 254 253 252 251 250 etc.

We may for convenience call each number in the lower row the complement of the number which stands above it. Now arrange the numbers from 1 to 32 as in Fig. 10, and separate the rows into pairs as is indicated by the lines. Then place the eight numbers in the first pair of rows and their complements, sixteen numbers in all, in a square of sixteen cells in the same order from the least to the greatest, as the numbers are arranged in Fig. 9. The resulting square is shown in Fig. 11. Take now the numbers in the second pair of rows with their complements, and make another square. Proceed in the same manner with the third and fourth pairs. This gives four squares of sixteen numbers each, and these four, arranged one below the other in regular order, form one side of the great square of 256 numbers. Now arrange the next thirty-two numbers, from 33 to 64, as the first thirty-two are arranged in Fig. 10, and form with them and their

1	16	17	32
2	15	18	31
3	14	19	30
4	13	20	29
5	12	21	28
6	11	22	27
7	10	23	26
8	9	24	25

FIG. 10.

complements four more squares in the same manner that the first four were formed. These placed in regular order at the right of the first four form another column of the great square. Do the same with the numbers from 65 to 96 and from 97 to 128, arranging the resulting squares as before. This completes the great square as shown in Fig. 11.

This large square possesses the following properties

226	255	18	15	194	223	50	47	162	191	82	79	130	159	114	111
32	1	240	241	64	33	208	209	96	65	176	177	128	97	144	145
239	242	31	2	207	210	63	34	175	178	95	66	143	146	127	98
17	16	225	256	49	48	193	224	81	80	161	192	113	112	129	160
228	253	20	13	196	221	52	45	164	189	84	77	132	157	116	109
30	3	238	243	62	35	206	211	94	67	174	179	126	99	142	147
237	244	29	4	205	212	61	36	173	180	93	68	141	148	125	100
19	14	227	254	51	46	195	222	83	78	163	190	115	110	131	158
230	251	22	11	198	219	54	43	166	187	86	75	134	155	118	107
28	5	236	245	60	37	204	213	92	69	172	181	124	101	140	149
235	246	27	6	203	214	59	38	171	182	91	70	159	150	123	102
21	12	229	252	53	44	197	220	85	76	165	188	117	108	133	156
232	249	24	9	200	217	56	41	168	185	88	73	136	153	120	105
26	7	234	247	58	39	202	215	90	71	170	183	122	103	138	151
233	248	25	8	201	216	57	40	169	184	89	72	137	152	121	104
23	10	231	250	55	42	199	218	87	74	167	186	119	106	135	154

FIG. 11.

in addition to that of a constant sum by the addition of rows or columns:

1. The numbers are arranged in pairs of which the sum is alternately 256 and 258.

2. The sum of the four numbers in any four cells forming a square, wherever taken, is equal to 2 (256 + 1).

3. The sum of the sixteen numbers in any sixteen cells forming a square is equal to 8 (256 + 1).

4. The sum of the thirty-six numbers in any thirty-six cells forming a square is equal to 18 (256 + 1).

5. The sum of the four corner numbers of either of these squares is equal to 2 (256 + 1).

6. The sum of the numbers in any bent row is equal to 8 (256 + 1). Thus, from 21 to 45 and then from 164 to 156 is a bent row.

7. If the square be divided through the middle, either perpendicularly or horizontally, the halves may be transposed, and the properties of the square will remain the same as before.

8. If the square be cut into 16 squares, any four of them will make a magic square of 64 cells, and any nine of them will make one of 144 cells. Consequently, as many magic squares of 64 cells can be made of the 16 partial squares as there are different combinations of sixteen things taken in groups of four, and as many of 144 cells as there are combinations of sixteen things taken in groups of nine. WILLIAM T. ORMISTON.

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THE CAUSES OF THE EXPLOSIVE EFFECT OF MODERN SMALL CALIBER BULLETS.

By CHARLES E. WOODRUFF, M.D., United States army, Jackson Barracks, New Orleans, and published in The New York Medical Journal.

FOR some time there has been the utmost confusion in our views as to the causes of the explosive effects of the new army bullet. Writers first affirmed that this small caliber bullet, moving with great rapidity, went through the tissues like a bullet making a small hole through a pane of glass, or as in the old experiment of shooting a tallow candle through a door. Then came reports of frightful destruction of tissue, just as though the bullet had exploded. Then came contradictory reports as to the zone in which the bullet had these terrible effects, some asserting that it was at short range, while others said it was at the short and long ranges, but not in the middle ranges (five hundred to eight hundred yards). Then came reports of both simple penetration and again of explosive effects at any range, until we were confused beyond hope. Instead of being under the guidance of fixed physical laws, the bullet seemed to be as fickle as the winds—now severe, now mild in action, and always lawless. Hence opinions have been as widely separated as well could be. When a soldier was killed at short range by the new bullet and his skull literally shattered to pieces as though dynamite had been exploded in his brain, his cerebrum pulpified and both lobes of the cerebellum found on one side, one "expert," who was interviewed by a newspaper reporter, stated that the bullet would go straight through the skull, making only a tiny hole; and an army surgeon who saw the frightful results expressed the opinion that there was no explosive effect whatever. In one article we found a surgeon dilating upon the humanity and non-destructiveness of the new rifle, while simultaneously there would appear another article describing the frightful destruction wrought and characterizing the weapon as an invention of the devil. In other words, the bullet sometimes goes through the tissues, producing so little harm that the soldier keeps on fighting, not even knowing he is hurt, while right at his side a comrade is struck down and instantly killed.

It began to dawn on observers that the results depended entirely upon the physical condition of the tissue struck, and many have been the attempts to explain why at one time the bullet should be so benign and at another so vicious. All sorts of theories have been put forth and much experimenting has been done, only to deepen the mystery. The matter has been worked out abroad, and we need not repeat it if we could only get at the results; but, unfortunately, the only reliable report sent to this country was secured under the promise of secrecy, and but few know of its existence; hence we must continue to flounder around in the dark. Very fortunately, a profound mathematician has given to the writer a hint as to the underlying laws which explain and classify all the bizarre effects of this little eccentric bullet.

Without going deeply into this subject, a work, by the way, which cannot be accomplished except by a profound mathematician, it is sufficient for us to know that the underlying laws have relation almost exclusively to the capability or incapability of the tissues to take up and transmit vibrations or wave motions, and to one ignorant of this subject it is extremely difficult to explain the effects of wave motion or rhythmic vibrations. It is well known, for instance, that by simply drawing a violin bow gently across the edge of a pane of glass it is possible to cause vibrations so violent as to shatter the glass into minute fragments. By simply breathing upon a heavy pendulum rhythmically and in consonance with its time of oscillation, it is possible to cause it to swing violently and do immense damage to that which opposes its motion. A tuning fork, by the wave motion it sets up in the air, can cause another fork to take up the motion, if it is capable of vibrating in unison with the first, and give out sounds representing very great energy. Our windows are shattered by the wave motions in the air caused by cannonading. Other illustrations are given in profusion in works on higher mathematics—works of which physicians, unfortunately, are, as a rule, densely ignorant.

Now, in these illustrations we find one of the chief causes of these remarkable exhibitions of power in the new bullet—not the sole cause, of course, because such a missile has numerous ways of exhibiting its energy derived from the explosion of the gunpowder. The bullet can be well likened to the violin bow, the tuning fork or any other object giving forth rhythmical impulses. It not only gets a movement of translation, but of rotation from the gun barrel, and in its passage through the air, as well as through the gun barrel, it is acted on by other forces of a most complex nature; and as a result of all these, it is set into vibration of extreme rapidity and force. It is not a body moving straight ahead without any other motion, but is twisting, turning, vibrating and trembling with a rapidity and force difficult of conception. It transmits these vibrations to everything with which it comes in contact. Those vibrations capable of being taken up by the air are carried to the ear in that well known "whistling" or "ping" of the bullet as it speeds along. As the bullet may vibrate and oscillate perhaps thousands of times a second, we can well imagine that it can give to the air vibrations so numerous that the resulting tone may even be too high pitched to be perceived by the human ear.

Now, in entering solid tissues, it does exactly as it does in the air, and whenever it touches a tissue capable, like a tuning fork, of taking up the vibrations, that tissue may be set into such violent vibrations that, like the pane of glass, it may be strained beyond its limit of elasticity, and may fly to pieces.

Yet we know that sometimes it goes straight through the bone, making a clean, small hole. Why is it, then, that no vibrations have been given to the bone in such cases? This is somewhat complicated, but due in great part, if not entirely, to the position of the blow in relation to the nodal points of the part.

The nodal point is a point on a piano string which does not vibrate, as, for instance, at a, b and c, Fig. 1.

FIG. 1.

Every baseball player knows that there is a certain point of his bat near the end where, if the ball strikes it, the bat does not vibrate. If struck above or below this point the bat vibrates and stings the hands. This point is the "center of gyration" or "center of percussion," a point at which the whole bat acts as a single force. If the bat is hung up and shot at this point, it is affected just as though it were a small body, but, struck above or below this point, it will be thrown into vibrations. The same law applies to the larger bones, and if the vibrations carry the particles beyond their limits of elasticity, they break instead of vibrating, just as the pane of glass will break under the influence of the violin bow. Thus, a man shot in the ankle may have the tibia shattered at its upper end, necessitating amputation above the knee (an actual case), but if shot above the ankle at a nodal point, there may be but a small hole that easily heals up. We must not confound the center of percussion with the nodal points existing after the vibrations begin. They may not be coincident at all, and a bone may break at the center of percussion. Indeed, the center of percussion may be anywhere in the body, according to the point from which

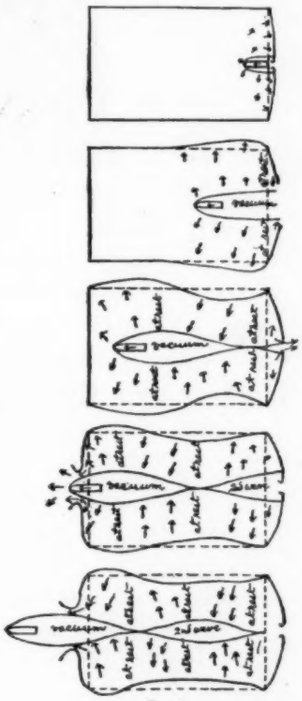

FIG. 2.

it is suspended. Experiments with bones are subsequently detailed. In every case the bullet makes a small round hole of entrance, because it moves so quickly that it overcomes the cohesion of the particles it touches long before it could possibly overcome the inertia of any other particles or of the whole mass. We see this in every wound, but we see the shattering in addition in those cases in which vibrations have been taken up subsequently. Sometimes the exit opening is also very small, showing that the bullet has here also gone through without disturbing the inertia of the whole mass, but that the vibrations have kept up after it passed through.

It is not necessary that the vibrations be of only one wave length, such as a pure tone is; there may be superimposed vibrations, like overtones, or numerous discordant waves simultaneously. A cart wheel does not give out a musical tone, but it may give out vibrations of great power.

In the case of fluids a wave motion is set up by an entirely different process. As in all other media, the bullet must make room for itself by pushing the fluid particles to one side as it "noses" its way through. Fluids being incompressible, the total bulk is then increased by the bulk of the bullet, and in slow moving bodies that is all the effect produced. It is no more than the effect of pushing a probe into the brain.

When the velocity is great, an entirely new factor enters. The particles of fluid making way for the bullet are given a tremendous centrifugal velocity, which they impart to all surrounding particles, even to the extreme outer layers (see Fig. 2). The fluid being incompressible, the particles at the bullet cannot move until surrounding ones make room for them. Consequently there is an instantaneous outward or centrifugal motion of all the fluid surrounding the point of the bullet. As soon as they make room the bullet enters. Now these particles of fluid are moving so rapidly that they possess considerable energy of motion, and they cannot be stopped until this energy is taken up, and the greater their velocity, the more difficult it is to stop them, for the energy is proportional to the square of the velocity. Before they stop they can do great damage—i. e., overcome considerable resistance. As this resistance is not instantaneously applied, the particles keep on moving long after they have made room for the bullet. They are stopped slowly, just as a railroad train is stopped slowly, unless the resistance it has to overcome is of tremendous power, as when it meets another train "head on." The particles of fluid moving away from the bullet track, even after the bullet has passed, must then form a vacuum or cavity. This cavitation is at the basis of the explosive effects in fluids, for it enables the whole mass to expand, as we shall subsequently see. The increase in volume caused by the introduction of the bullet itself is so small that it can well be ignored. The enormous extent of the cavity or vacuum thus formed depends solely upon the velocity of the particles moving outward centrifugally from the track of the bullet. As their energy is proportional to the square of their velocity, it is evident that doubling their velocity increases their energy fourfold, and they can overcome four times the resistance before they are brought to rest. The resistances are, of course, the strength of the materials of the walls of the tissue containing fluid, and they bulge out these walls until they burst or until they stop the motion. We will call this bulging the "ballooning" effect.

As soon as the particles are brought to rest they are acted on by the forces driving them back, for they now surround a vacuum. They rush back again to the track of the bullet, and come together with great force, rebounding perhaps for a second excursion outward. All these movements follow the bullet—they are true wave motions. In the ordinary waves on the surface of a fluid, the motions of the particles are entirely different; they are circles or other curves; but in the waves produced by the bullet the particles move in straight lines perpendicular to the direction of the motion of the bullet, and the bullet, of course, moves in the direction of its long axis. The particles vibrate back and forth in these radii, or in approximations to these lines, according to the resistances they meet. The particles which rush together in the vacuum behind the bullet come together with terrific force, some of which is turned into heat, sound and other vibrations, but considerable may remain, and the particles rebound from each other, creating a second vacuum, and continuing their outward journeys until stopped by resistances when they return. They thus vibrate back and forth until their energy is dissipated and the fluid is at rest. The amplitude of the vibration (the extent of movement) of course gradually lessens, as it does in a piano string. The amplitude depends entirely upon the velocity of the particles and the resistances they meet.

When the particles rush outward they may only balloon out the vessel and not break it; in that case the walls are simply dragged back into place again. Sometimes the walls are forced outward into such shape that they do not readily return; in that case the weakest parts may collapse. Should the walls break, allowing some of the liquid to escape, then, of course, the collapse of the walls by the return wave will be very marked.

It is therefore very evident why rapidly moving bullets create such havoc in fluid tissues, and why it is that the greater the velocity, the greater the damage. The brain, for instance, after such vibratory movements, is churned into a mushlike mass. The skull will be bulged out and drawn in perhaps several times, and we can see, then, the cause of such shattering of the whole cranium.

When the bullet has passed nearly through the fluid and is about to strike the rear wall it has given a tremendous blow to all the fluid particles surrounding it. They are moving out of the way, and exerting great pressure. The instant the bullet breaks through the rear wall the edges of the break are immediately forced outward by the fluid making a large, ragged exit opening, as seen in the diagram, Fig. 2.

The vacuum following a solid moving very rapidly through gas or fluid is a well known phenomenon, which is now figuring very much in mechanics. We can see how it is produced by merely moving the hand rapidly through the water in a bath tub; but, of course, it is not formed to any extent by such a low velocity. This subject is receiving the greatest practical application in marine engineering, by what is denominated the "cavitation" of screw propellers driven at high speed. It is found that at the higher velocities this vacuum actually puts a limit to the speed of propellers beyond which the energy of the engine is not used in thrusting the boat forward, but is expended in thrusting the water backward and forming a cavity in front of the blades. By increasing the propeller surface without altering its pitch or diameter, the speed of the ship may be maintained by far less horse power, and the "slip" or difference between the speed of the propeller and that of the ship may be materially diminished. The word cavitation is used because in such velocities the space is not probably a vacuum, but is filled with water vapor, for we know that water will burst into vapor in a vacuum at ordinary temperatures. In the case of the bullet it is manifestly impossible to say whether the cavity is a vacuum or whether it is filled with vapor, but in either case the effect is the same. Mr. S. W. Barnaby and Mr. Thornycroft have explained the matter of cavitation in a paper read before the International Congress of Naval Architects and Marine Engineers (see Popular Science Monthly, November, 1897).

In order to prove the vibratory character of these

movements, numerous experiments have been made by shooting into ordinary tomato cans, as described below. Their great advantage exists in that they remain in the position to which their walls were forced by the last wave or vibration of sufficient energy to move them—sometimes ballooned out, sometimes collapsed. Bones and other live tissues will not do this; hence such experiments are quite difficult to interpret, but in rigid tin cans we have a permanent record left by the waves. The skull, for instance, is ballooned out to a terrific extent, fracturing it into many pieces, but the tensile strength of the surrounding membranes prevents their own rupture, and their elasticity forces the skull back into its original shape, and we have no record of the wave except its damage. It is like finding the wreckage on the shore after the waves have pounded the ship to pieces.

In the accompanying diagram, Fig. 2, an attempt is made to show graphically the fluid waves or vibrations caused by the bullet. It is purely diagrammatic, because we do not know the wave length, or its rhythm, or its amplitude (or height). It may have a wave length of many feet, so that only part of one wave can be in the can at one time. Nevertheless, it shows very plainly how the cans are forced into the shapes in which we find them. Whether the cans burst or collapse depends entirely upon their strength relatively to that of the moving fluids. The arrows indicate direction of motion of the fluid particles, and not necessarily directions of pressure. By studying the diagram first, the experiments can be easily interpreted.

EXPERIMENTS WITH TOMATO CANS—ALL SHOTS FIRED THROUGH CANS FROM ONE END TO THE OTHER.

Experiment I.—Empty and sealed. Small entrance and exit holes were identical. They were small, as if cut out with a punch, though the edges were slightly inverted and everted respectively. Shape of can unaltered.

Experiment II.—Empty and sealed. Small entrance hole as in Experiment I, but exit was a trifle larger and its edges more everted than in Experiment I. Air being compressible, these two cans show that the air displaced by the bullet was merely forced or compressed into the surrounding layers, and transmitted a wave too feeble to change the shape of the can.

Experiment III.—Full of water, a small vent hole being unsealed. Entrance hole as in Experiment I; exit hole irregular, about an inch and a half across, with jagged, everted edges. Front end bulged out, as by internal pressure; rear end was torn loose almost entirely at soldered edge, and, after the bullet had passed through, the end swung out a hundred and eighty degrees around the small strip of uninjured edge acting as a hinge. This shows that the pressure or forces which forced the ends out acted after the bullet had passed through the can, as a vibration or wave would act. The sides partly collapsed, perhaps from the vacuum caused by the escaping contents or by vacuum caused by the receding wave. Anyhow, we see results in this can of both positive and negative pressure, bulging and collapsing. If it were hydrostatic pressure from within, there would be no collapsing.

Experiment IV.—Full of water, sealed. Result same as Experiment III, except that rear end was not entirely torn loose.

Experiment V.—About two-thirds full of water, a vent hole being unsealed. First shot went through upper air stratum, with results as in Experiment I. The second bullet went through the water near its surface. Entrance hole same as in Experiment I; exit hole was an inch in diameter, irregularly oval and jagged edges, everted as in Experiments III and IV. The ends were slightly bulged out and the sides slightly collapsed. As the bullet went so near to the surface of the water it is quite evident that the waves could be but slight in extent, and the air being very compressible prevented them from exerting their full force on the ends of the cans. In other words, the bullet churned a groove in the fluid, most of the motion being upward into the air in the upper part of the can. The particles of moving fluid took the path of least resistance, as all moving bodies do, and many of those moving downward, which might have bulged out the can, undoubtedly were reflected to one side, their entire force being expended on the can as a whole, and not on the lower wall.

Experiment VI.—About two-thirds full of water, sealed. The bullet went through lower layer of water. Entrance and exit as in Experiments III and IV. Front end was slightly bulged out, and for one-fourth of its circumference was torn loose and everted, while the adjacent side was collapsed and inverted. The rear end was slightly bulged out, about half its soldered edges being torn loose. The sides were partly collapsed. The damage done was not nearly so great as in Experiments III and IV. This can be explained by supposing that the compressible air did not allow the vibrations to be carried to the can, for the upper third of the can, which was in contact with the layer of air, was practically uninjured. The collapsing was, of course, due to the return rush of fluid in the second half of the first wave. A series of transverse ridges of this part of the can may have been due to vibrations transmitted to the block of wood on which the can rested, and it also has the appearance of having been first flattened down on the wood by the first ballooning before it collapsed. These ridges remind one of the marks on the seashore left by the small waves or ripples.

Experiment VII.—Can of tomatoes, just as it came from the shop, containing a large bubble of air. Result almost the same as Experiment III—i. e., small entrance opening, bulged front end, rear end torn almost entirely off, and swung around ninety degrees after the bullet had gone through. Sides collapsed into triangular shape at rear end after the end was blown off. A longitudinal soldered edge was blown open at the collapsed end, showing that just before the negative pressure, which collapsed this end, there must have been a positive or outward pressure. This was at the upper side, which in Experiment VI, containing air, was unchanged. The pressure or injury was thus transmitted to the top, though the bullet passed through the lower fifth of the can. The side in contact with the wooden block was evidently flattened on the wood by the first wave, and shows the same ridges perpendicular to the axis of the bullet motion as in Experiment VI.

(To be continued.)

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